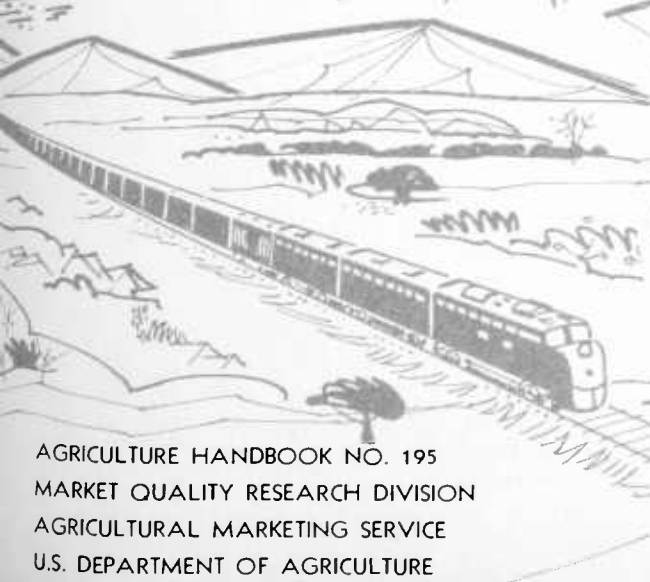
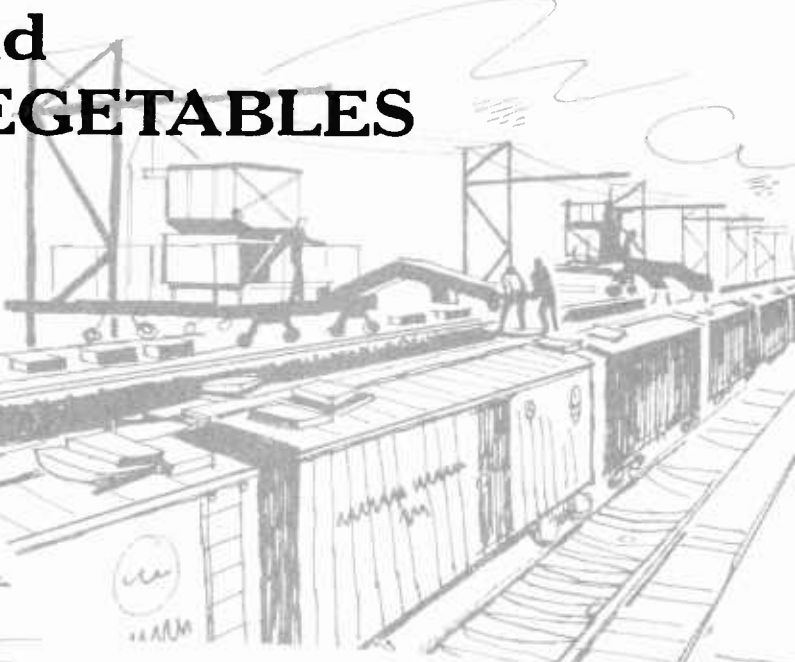




# Protection of RAIL SHIPMENTS of FRUITS and VEGETABLES



# **Protection of RAIL SHIPMENTS of FRUITS and VEGETABLES**

By W. H. Redit and A. A. Hamer

July 1961

Agriculture Handbook No. 195  
Market Quality Research Division  
Agricultural Marketing Service  
U. S. Department of Agriculture



Growth Through Agricultural Progress

## PREFACE

The purpose of this handbook is to help shippers of fresh fruits and vegetables to select the most desirable rail protective services available, based on commodity characteristics, seasonal needs, geographical location, and cost. Preparation of the handbook has been requested by the Transportation Research Advisory Committee to the Department of Agriculture as well as by railroads, carlines, shippers, receivers, and various freight loss and damage prevention agencies.

Much information on the desired commodity environment during transit and the way it can be achieved by proper use of equipment and protective services has been developed by the Department of Agriculture in transportation studies over the past 50 years. This information has been made available to the industry in numerous Government and scientific publications, many of which are now out of print. Compilation of these data into a handbook makes these findings available to all who handle perishable agricultural products.

Most of the recommendations contained in this handbook are based on the results of transportation studies conducted by the Department. However, a number of commercially important crops and producing areas were not included in the observations. For these crops and areas, several commercially used protective services have been considered and tentative recommendations made. All of the recommendations in this handbook are based on provisions of the Perishable Protective Tariffs published by the National Perishable Freight Committee and the REA Express. Because containers and loading methods appear to be amply covered in the various Freight Container Tariffs, no reference to them is made in the handbook except where they definitely influence the effectiveness of the protective service prescribed.

This first edition of the handbook is tentative. Necessary revisions will be made as additional information is developed. Possibly the present scope of coverage and presentation is inadequate; therefore, suggestions for improvement are invited. Some of the factors that may alter presently recommended protective services include new types and sizes of containers, heavier loading, faster train schedules, improved rail equipment, wider use of precooling, and the adoption of new and more effective fungicidal treatments.

## USDA Field Offices

For further information relative to specific crops in the various growing areas, or market diseases or other disorders, readers may contact the appropriate Agricultural Marketing Service office listed below:

California: U.S. Horticultural Field Laboratory (AMS), 2021 South Peach Avenue, Fresno 2; U.S. Horticultural Field Laboratory (AMS), P.O. Box 700, Pomona.

Florida: U.S. Horticultural Field Laboratory (AMS), 2120 Camden Road, Orlando; U.S. Horticultural Sub-Field Laboratory, 13601 Cutler Road, Miami 56.

Illinois: U.S. Market Pathology Laboratory (AMS), 536 South Clark Street, Chicago.

Maine: Maine Potato Research Center (AMS), Box 532, Presque Isle.

Minnesota: Red River Valley Potato Research Center (AMS), P.O. Box 113, East Grand Forks.

North Carolina: U.S. Horticultural Field Laboratory (AMS), Kilgore Hall, N.C. Agricultural Experiment Station, Raleigh.

New York: U.S. Market Pathology Laboratory (AMS), 641 Washington Street, New York.

Texas: U.S. Horticultural Field Laboratory (AMS), P.O. Box 1425, Harlingen.

Washington: U.S. Horticultural Field Laboratory (AMS), P.O. Box 99, Wenatchee.

## Acknowledgments

In the preparation of this handbook, many of the data were supplied by members of the Market Quality Research Division.

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Acknowledgment is given for the use of some of the figures as follows: Fruit Growers Express Company for figure 5; National Freight Container Bureau, Association of American Railroads for figures 10, 11, 12, 13 and 27; and Preco Inc. for figures 2, 4, 6, and 8.

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# Protection of Rail Shipments of Fruits and Vegetables

By W. H. REDIT, mechanical engineer, and A. A. HAMER, engineering aid,  
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## INTRODUCTION

Preserving the harvest-fresh quality of perishable agricultural commodities is of great importance in this era of ever-increasing costs of production, distribution, and marketing. To hold present markets and to develop new outlets, only high-quality commodities can compete for the consumer's dollar. Losses from deterioration during distribution must be kept to a minimum. Rail transportation is a vital link in the chain of distribution. Time in transit may represent the largest portion of the post-harvest life of some of the more perishable commodities such as cherries, strawberries, broccoli, and spinach, so that environment during this period will largely determine the salability of the produce when it reaches the consumer.

The part that rail transportation has played in the development of our present-day agriculture is well known. The Department of Agriculture has conducted research for many years on the transit requirements of perishable commodities. In addition much effort has been devoted to developing and testing the performance of improved types of railroad refrigerator cars. This has been done in cooperation with railroads, carlines, shippers, receivers, State experiment stations, equipment builders, and others in the industry. As a result, greatly improved transit conditions for fruits and vegetables as well as considerable savings to the shippers have been made possible by the development of more economical protective services.

A number of factors influence the selection of the right protective service as perishable commodities move from farm to market. These include kind and variety of crop, condition of the product, packaging, precooling, length of storage before shipment, loading methods, weather, distance to market, train schedules, and type of rail equipment used.

Many different kinds of refrigeration, heating, and ventilating services are available. Generally, the shipper or the receiver has the responsibility for selecting the protective service for his commodity in transit. To assist in this selection, the sections that follow present briefly the transit environmental requirements for most of the commercially shipped horticultural commodities and ways to meet these requirements through proper selection of equipment and available services. Recommended protective services for specific commodities are given in tables 7, 8, and 9, pages 64-102.

The recommendations in this handbook should not be considered absolute or final. They indicate a range of conditions in which these commodities may be satisfactorily and economically shipped after consideration of the variable factors mentioned above. As the primary objective has been to consolidate all such information into a practical guidebook, it has been necessary to omit many details. However, more detailed information is available elsewhere in bulletins, reports, and reprints, many of which are listed in the Literature Cited.

## RAIL TRANSIT EQUIPMENT

A description of the modern refrigerator car, some background on its development, and a brief outline of the facilities and methods for servicing it may help users of this handbook.

Mr. Hamer retired in 1960.

### The Refrigerator Car

*History.*—The introduction and development of the rail refrigerator car during the mid-1800's sparked the rapid expansion of agricul-

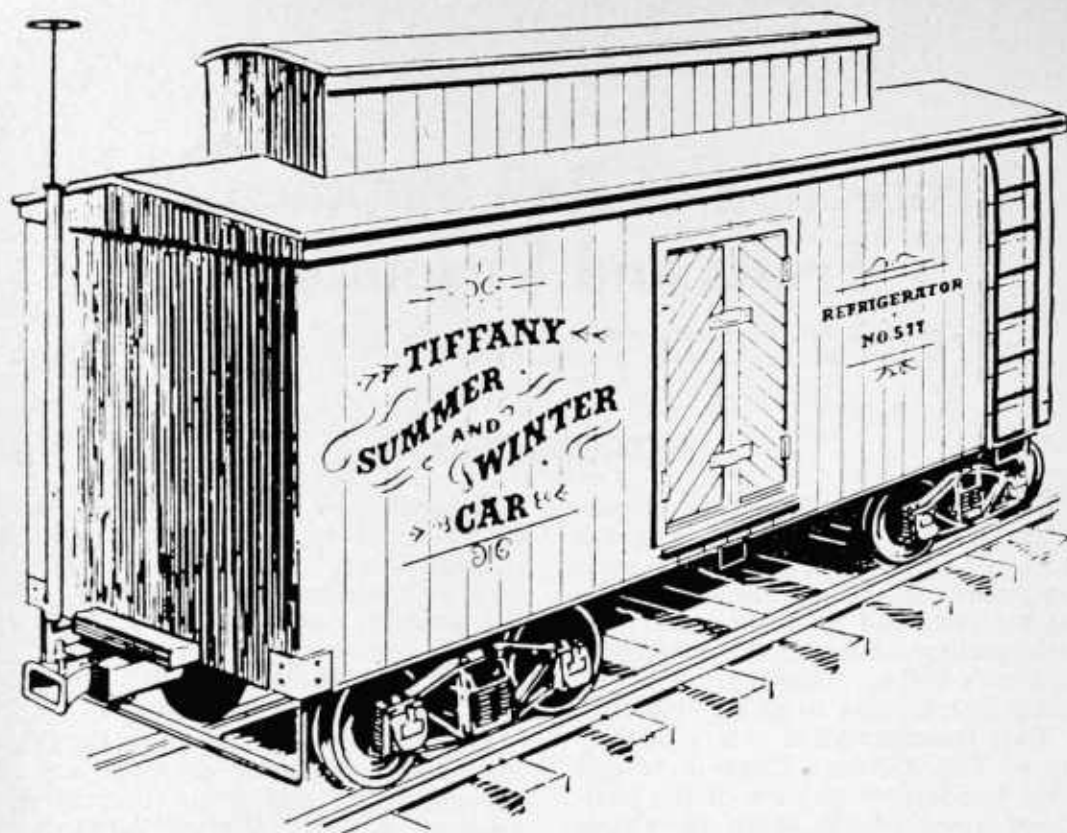


FIGURE 1.—An early refrigerator car.

tural production in Florida, California, the Pacific Northwest, and other specialized producing areas. With the means available to move fresh produce safely to markets many miles away, growers concentrated on large-scale production of crops best suited to soil and growing conditions of those areas.

The first refrigerator cars were little more than boxcars with ice placed in them to ship berries or meat a few miles to market (fig. 1). Cars were gradually developed with special ice compartments, greater ice capacity, and some insulation. By 1890 carloads of oranges, apricots, cherries, and strawberries were being shipped from California to eastern markets in refrigerator cars operated by the railroads and private carlines. In 1905, the U.S. Department of Agriculture began studies of commodity temperatures in transit and of car modifications to improve both service and equipment. As a result of these early studies, basic improvements were developed in car design which were adopted and put into effect by the Railroad Administration in 1918. These included the use of basket-type bunkers, floor racks, and increased insulation. During the next 20 years,

further research by the Department and the refrigerator car owners was done on modified icing services, half-stage icing, various kinds of insulation, and air circulating fans. In 1938, the first car fans were installed. At about the same time, different types of car heaters were developed by some of the carlines and tested in cooperation with the Department.

In 1944, the Refrigerator Car Committee of the United Fresh Fruit and Vegetable Association was formed to foster improvements in the refrigerator car for the postwar rebuilding period. In cooperation with this committee, the U.S. Department of Agriculture, the railroads, and some of the refrigerator carlines conducted an extensive research and testing program culminating in certain recommendations for the refrigerator car as we know it today. These included easy-riding trucks, steel framing, improved draft gears, half-stage ice racks, thicker and improved insulation, and forced air circulation. Thermostatically controlled alcohol (LF) heaters were also developed and tested during this period. They are standard equipment on many lines today. The development of the mechanically refrigerated

# THE MODERN REFRIGERATOR CAR

## FEATURING AIR CIRCULATING FANS AND AUTOMATIC HEATERS

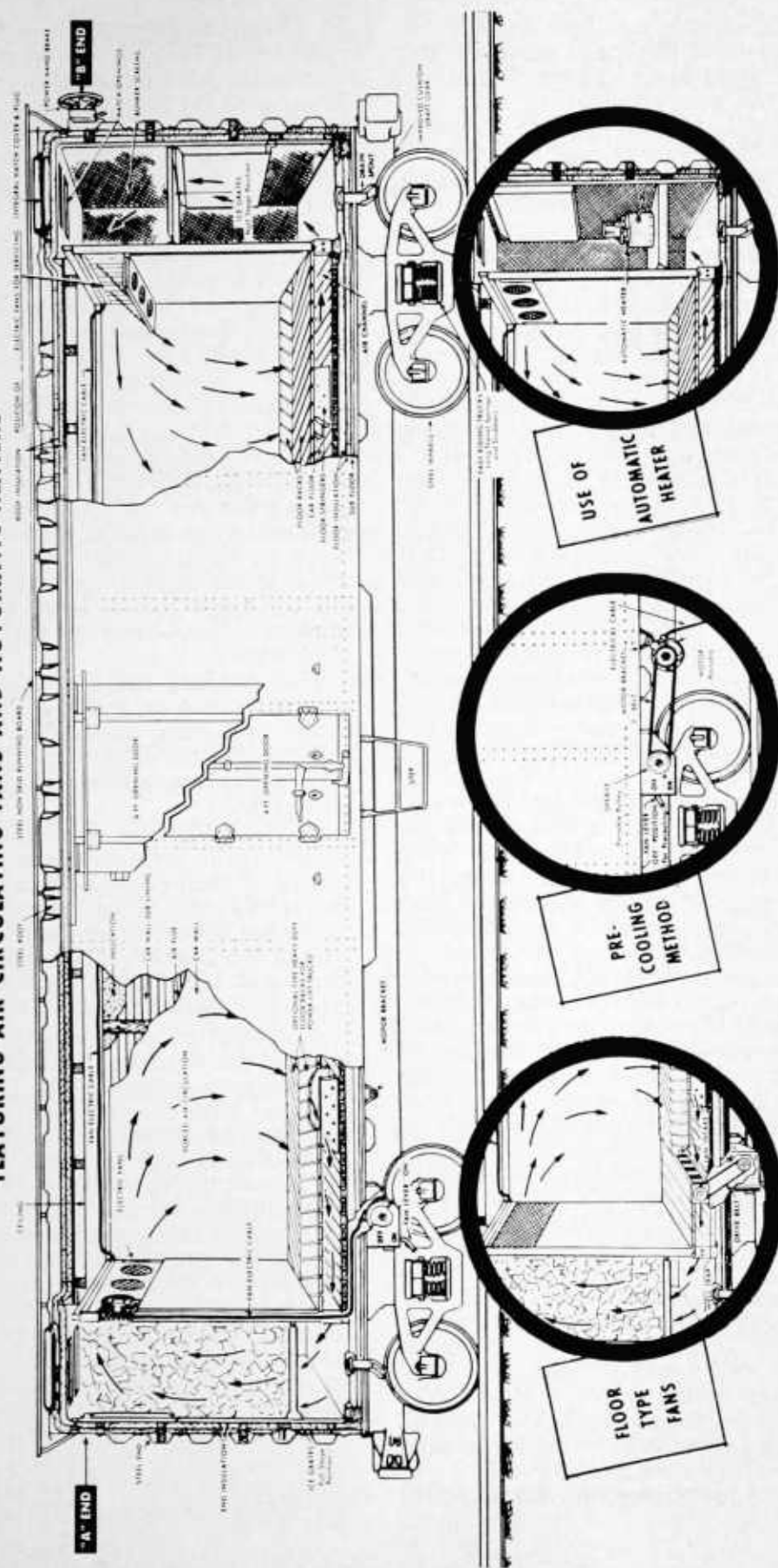


FIGURE 2.—The modern refrigerator car.

car was delayed by the war, but in 1949 the first car was placed in service to provide better protection for frozen foods in transit than was possible with ice and salt. Since that time many improvements have been made, including so-called "all purpose" mechanical cars suitable for carrying both fresh and frozen produce. Today there are about 5,500 mechanical cars in service with more under construction.

*Today's refrigerator car.* — Approximately 95,000 RS or general-service refrigerator cars are now in operation, nearly all being of the end-bunker type. Figure 2 is a diagram of the modern ice-bunker car showing its component parts and how it is used under various protective services (86).<sup>1</sup> Most of these cars now in service are approximately 40 feet in outside length but there are some 50-foot cars that are heavily insulated and used in special services.

Ice bunker capacity varies from about 9,000 pounds per car (both bunkers) to 12,000 pounds. Most cars now are equipped so that the ice grates can be raised to the halfway mark for upper-half-stage icing. Floor racks are provided for air circulation under the load and are hinged in sections to permit lifting for cleaning of car floor. Many cars also have vertical wall flues to permit air circulation around the load, regardless of the type of load or container. Flues are particularly valuable in preventing freezing damage in cold weather to lading placed tightly against the cold car walls, as heated air provided within the car moves down the flue opening and warms the inner wall lining. During hot weather, when the car is under refrigeration, air within the flues intercepts outside heat before it can affect the commodity temperature.

Two types of air circulating fans are now installed in over 70,000 RS cars; the mechanical or floor fan and the electric or overhead fan. Both types are illustrated in the diagram of figure 2. The adoption of car fans to provide forced air circulation is considered to be one of the most outstanding improvements in refrigerator cars in many years. With the use of the fans, more uniform temperatures are obtained, thereby eliminating excessively high temperatures in top layers and chilling or freezing damage in bottom layers, as shown in figure 3. Operating the car fans with auxiliary motors (electric or internal combustion) (fig. 4) provides rapid cooling or precooling at loading point and reduces the temperature spread when the car is held at terminal markets. Fans should be placed in the "ON" position (fig. 2) regardless of the protective service used or the commodity shipped, as provided for in Rule

84, National Perishable Freight Committee Circular 20-D (51), including cars moving under heater service and cars shipped with top ice. Because of the importance of car fans, the shipper should be certain they are in proper operating condition before loading a car, and the railroads should provide careful maintenance and inspection to insure they are in good order.

The hinged ice-bunker hatch covers and plugs may be opened to a number of positions to provide ventilation in the car and thus take advantage of low-temperature outside air to cool the load during certain seasons. The special tariff rules under which the ventilating devices are manipulated are discussed in the section on Protective Services Available.

All refrigerator cars built in the past 4 or 5 years are equipped with sliding doors, mostly 6 feet wide, permitting the use of mechanical loading devices such as forklift trucks. Other improvements include high-speed trucks with more resilient springs and snubber devices to promote smooth riding, better shock-absorbing draft gears to reduce coupling and slack action impacts, roller-bearing equipped axles, and steel wheels.

The standard car now has 4 to 6 inches of insulation in floor, walls, and ceiling to provide better protection and reduce refrigeration requirements. Some cars used in special service, such as for frozen foods, have up to 9 inches of insulation.

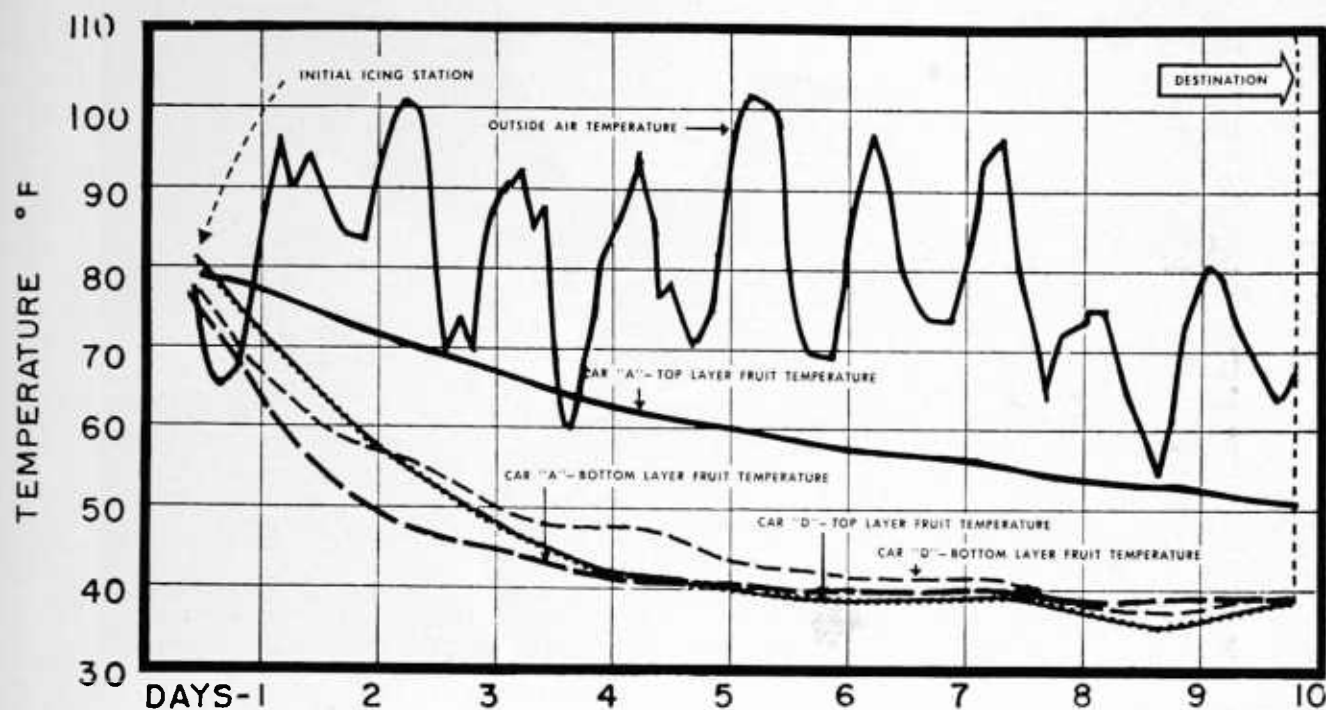
Refrigerator cars specially assigned to passenger train service are available for rapid transit of such crops as strawberries, cherries, and cut flowers. These express cars are usually somewhat over 50 feet long but have the same type of ice bunkers, floor racks, air circulating fans, and ventilating devices as the regular freight refrigerator cars.

A number of cars, mostly owned and operated by the Canadian railroads but also available in some parts of the United States, are equipped with overhead ice bunkers. The cars have proved satisfactory under certain conditions. With the ice bunkers overhead, the cooled air moves by convection currents down the sidewall flues for the entire length of the car, resulting in fairly uniform load temperatures. Forced air circulating fans are therefore unnecessary in this type of car. However, effective precooling of a warm load can only be accomplished with the use of mobile or track-side mechanical units; hence such cars are used mainly for frozen foods in the United States. They are equipped with underslung heaters for protection against freezing during the winter months.

In recent years, a large number of bunkerless refrigerator cars (RB type) with a mini-

<sup>1</sup> Italic numbers in parentheses refer to items in the Literature Cited, p. 103.

**REFRIGERATION OF ORANGES IN TRANSIT**  
**AVERAGE TOP AND BOTTOM LAYER FRUIT TEMPERATURES**  
**NON-FAN CAR "A" VERSUS FAN CAR "D"**  
**CALIFORNIA TO NEW YORK - STANDARD REFRIGERATION**



AMS Neg. 8151-60(10)

FIGURE 3.—Use of car fans provides more uniform temperatures and faster cooling in transit of shipments of warm oranges.

num of 3 to 3½ inches of insulation have been placed in service. Most of these cars are not equipped with ventilating devices. They are designed primarily for shipments of beverages and canned goods which require no refrigeration in transit.

### Mechanical Refrigerator Cars

While most of the available mechanical cars are being used in frozen food service, the majority are designed to also handle fresh produce within a range of 32° to 70°F. Many high-temperature test loads have been shipped with satisfactory results, especially commodities requiring temperatures near 32° such as lettuce, celery, and asparagus, or commodities that require minimum temperature variations in transit.

These cars are characterized by the type of air circulation provided within the loading space. The three principal types are open, complete envelope, and semi-envelope designs.

In the open design all of the cooled air is discharged directly over the load from a grill

in one end of the car or through openings in a ceiling duct; the air then passes down through the load and flues at the sides and ends of the car and returns to the unit via the space under the floor racks. This design is best adapted to precooling because most of the cold air can move through the load and thus pick up the field heat of the commodity.

In the complete envelope design, the cooled air is discharged into a ceiling duct and is circulated completely around the load by passing downward through side and end wall ducts and back to the refrigerating unit via a floor duct. The cooling air completely envelops the load but none enters the load space. This system is best adapted for frozen foods.

The semi-envelope design is similar to the complete envelope type except that conventional open-type floor racks are used instead of the enclosed floor duct, so some of the circulating cooled air enters the loading space (fig. 5). In a modification of this system, part of the cooled air is directed into the loading space through dampered openings or a series of openings in the ceiling duct. This design provides for faster

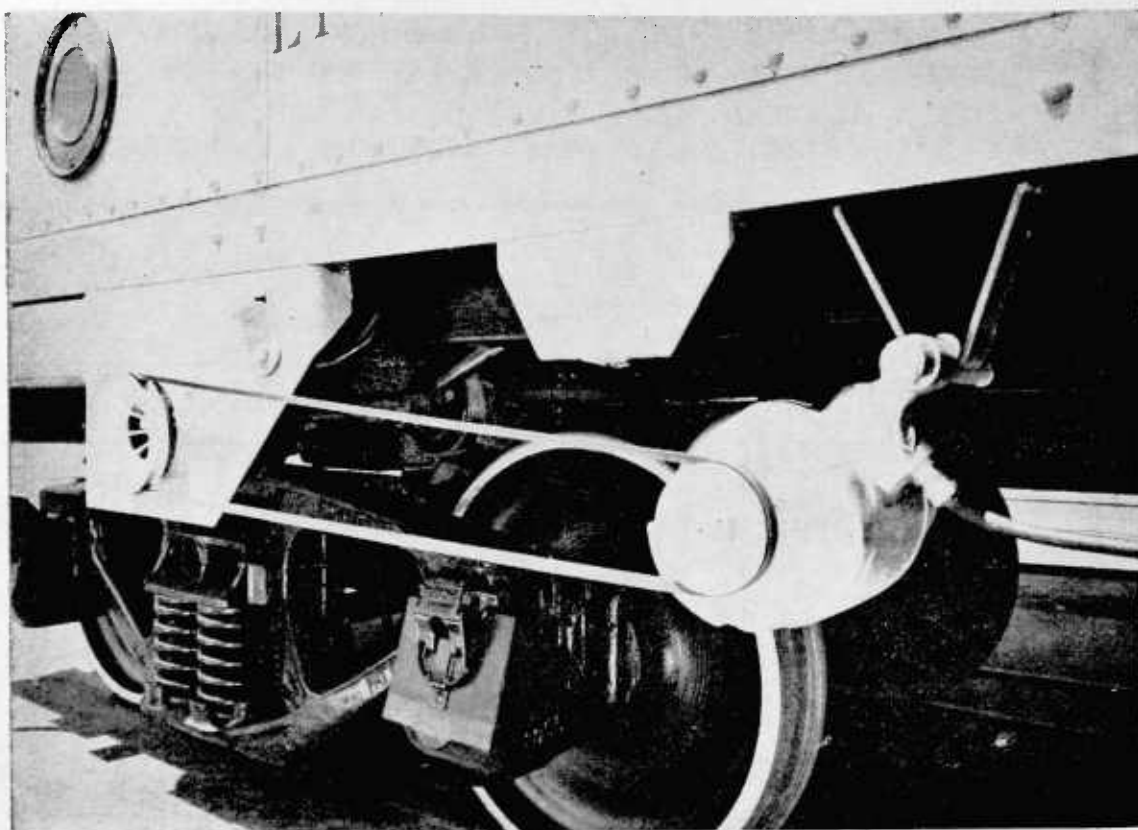


FIGURE 4.—Precooling motor which operates car fans.

cooling of a warm load although it is less effective than the open design. For commodities with a high heat of respiration, more uniform temperatures can be maintained when some air is moved through the load. With one other design used in some cars the air circulation is reversed by having the cooled air discharged under the floor racks or through a floor duct, moving upward through the wall flues or load, and returning through the ceiling duct.

Power for the refrigerating units and fans is generally supplied by diesel-electric units, although some cars employ a direct-connected gasoline or diesel engine. Plug-in standby operation from local sources of electricity may be substituted for the diesel-electric operation during loading or holdover periods at terminals when the noise and exhaust fumes from the engine are objectionable.

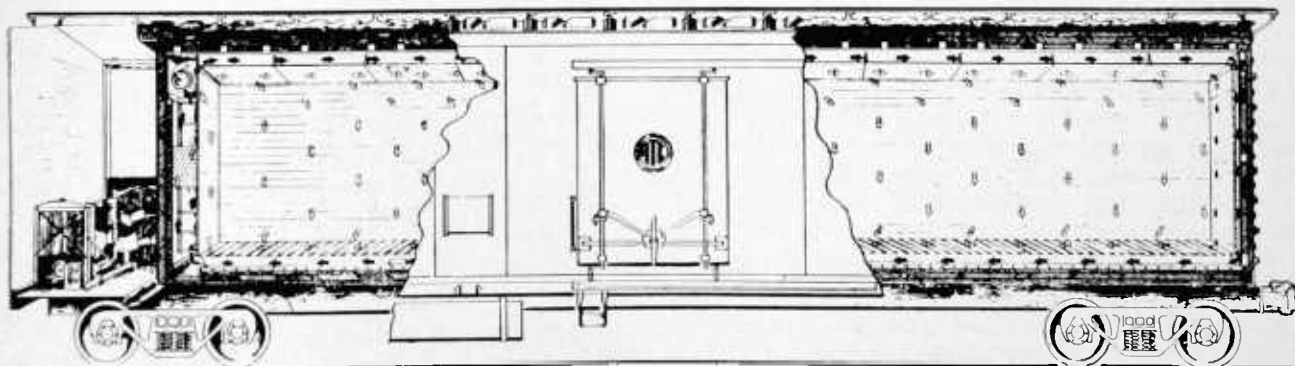


FIGURE 5.—Mechanical refrigerator car (semi-envelope type) showing location of refrigeration equipment and movement of air.

Automatic temperature control is provided in these cars. Under the provisions of Rule 710 (nonfrozen commodities) of the Perishable Protective Tariff the shipper is required to specify the transit temperature desired. The railroad representative will then set the car thermostat to provide this temperature. Because of the inherent temperature differential in different makes of thermostats and the necessity for defrosting equipment, some allowance is made for such variations when setting the thermostat. Table 4 on page 25 contains suggested temperatures to be specified by shipper for certain fresh fruits and vegetables shipped in mechanical cars. These temperatures allow for possible thermostat variations mentioned above.

Precooling of warm loads in a mechanical car of the open design or of the modified semi-envelope design (with openings in ceiling duct) is slower than with the best precooling methods in iced cars as previously described. The reasons are a slower velocity and lesser volume of air moving through the load and the capacity limits of the refrigerating unit. It is generally considered uneconomical to provide the refrigerating capacity required to quickly remove the field heat involved in a good precooling job as much of this capacity is not required thereafter to maintain temperatures in transit. However, some mechanical cars, in which the refrigeration capacity is around 50 percent greater than the average, are equipped to provide rapid precooling.

While cooling in mechanical cars may be slower, it is uninterrupted from the time the car doors are closed after loading. The cars do not need to be held at loading point for precooling. Earlier pickup and reduced transit time are therefore possible. Mechanical cars are well suited for commodities that are loaded at or near the desired transit temperatures after room precooling, hydrocooling, vacuum cooling, or loading out of cold storage. Charges for transit protective service in these cars for fresh produce or other nonfrozen commodities (above 32°F.) are approximately the same as for Standard Refrigeration Service.<sup>2</sup> On frozen food shipments the charges are about 50 percent greater than for Standard Refrigeration Service on fresh vegetables.

Mechanical cars equipped to handle the full range of both fresh and frozen commodities are designed to provide heat for cold-weather protection as well as refrigeration. The heat is supplied by means of electric heating elements or by reverse-cycle operation of the refrigerating unit in which the hot gas from the com-

pressor is sent into the cooling coils. The change from cooling to heating is done automatically by the thermostatic controls.

### Thermostatically Controlled Fan Cars

Two types of fan cars equipped with a small diesel-electric unit to provide current for continuous operation of car fans whether the car is moving or standing are now under test. In one type, operation of two corner fans in each end of the car is controlled by a thermostat. These fans circulate the air from the ice bunkers through the load space. A center fan in each end of the car operates continuously through a duct which bypasses the ice bunker area entirely, thereby eliminating any intake of cold air from the ice and circulating only the air that is already within the loading space. Thus, when the air temperature within the car reaches the thermostat setting, the corner cooling fans are shut off, but a uniform temperature is maintained by the continued operation of the bypass fans. To prevent cold air from the bunkers from flowing out under the floor racks and unduly cooling the bottom of the load when the cooling fans are off, thermostat action closes dampers over the corner fan openings.

In the other type of car there are no bypass fans. The three fans in each end operate continuously but their speed is reduced when the thermostat is satisfied. In this way some air circulation is maintained in the loading space but further cooling is greatly retarded.

Besides providing uniform, thermostatically controlled temperatures, full advantage may be taken in these cars of the savings afforded by the use of the various modified refrigeration or ventilation services (7). Also, better temperatures under heater services can be expected. For heater service, thermostatically controlled alcohol heaters are used and all car fans are kept operating continuously. Temperature control is thus obtained by means of the heater thermostats.

### Car Heaters

Protection against cold is provided by portable heaters placed in the empty ice bunkers. The standard charcoal heater is rapidly being replaced by the thermostatically controlled alcohol heater shown in figure 6. Temperature control in the car using charcoal heaters is provided by lighting one or more heaters, depending on predicted or prevailing outside air temperatures. This method does not take into account the conditions that actually exist inside the car, resulting many times in unsatisfactory control. Since the development of the thermos-

<sup>2</sup> See section on Protective Services Available.



FIGURE 6.—Thermostatically controlled alcohol heater installed on ice grates in car bunker.

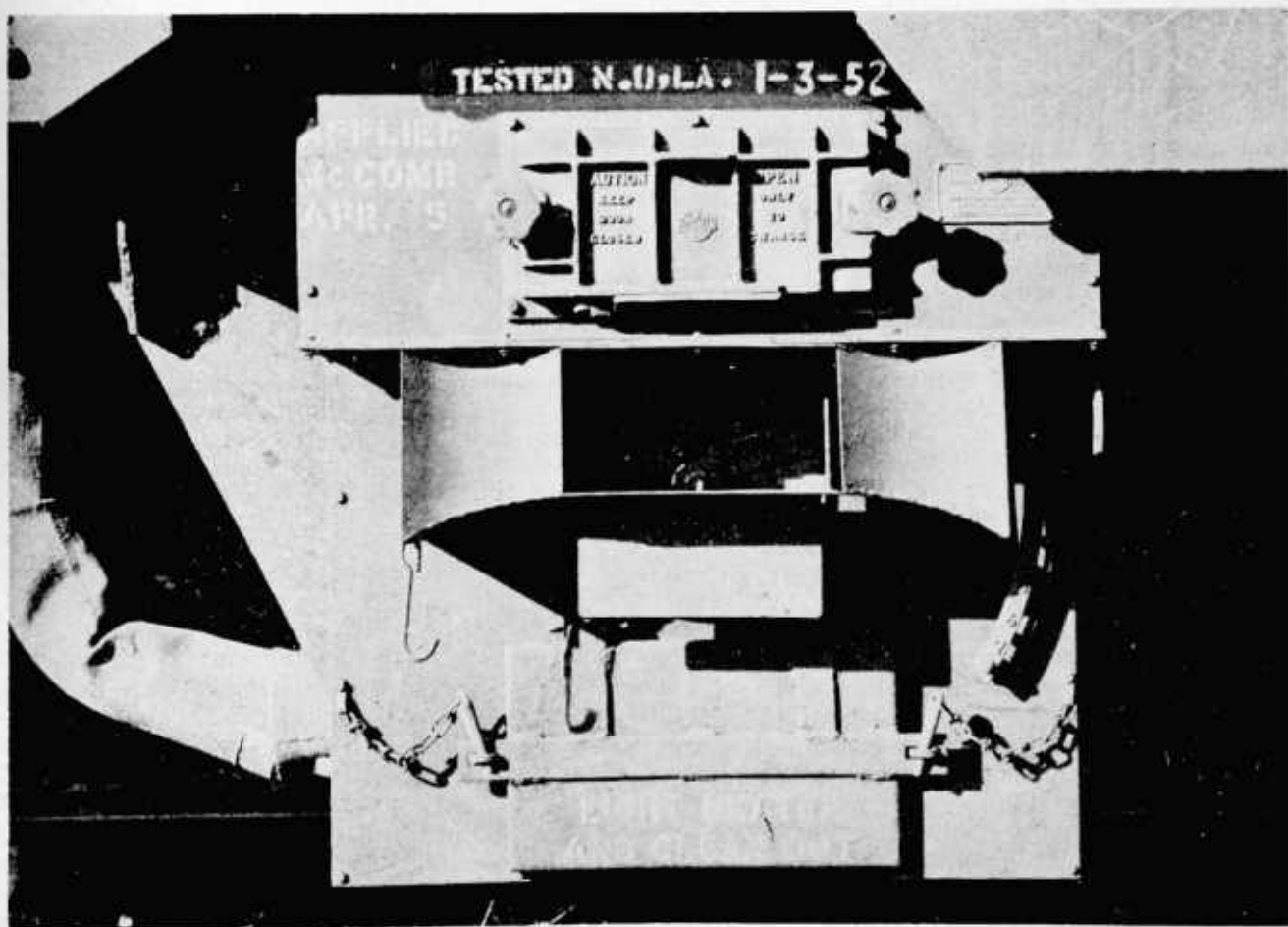


FIGURE 7.—Underslung charcoal heater.

tatically controlled alcohol heater, it is possible to provide protection based on air and commodity temperatures inside the car, greatly reducing both overheating and freezing damage. The heater pilots are usually lit when the heaters are installed in the car. With the heater thermostat set for the desired temperature, no further attention is normally required except to refuel the heaters. Operation of car fans under heater service is essential to obtain most effective use of both types of heaters.

Some refrigerator cars and special-purpose insulated boxcars are equipped with underslung charcoal heaters (fig. 7) which are mounted underneath the car near one of the doors. In one type, a copper coil surrounding the firebox contains ethylene glycol which, when heated, circulates by gravity through a pipe coil laid on the car floor under the floor racks. This applies heat to the bottom of the load where it is most desired and provides for uniform load temperatures without the need for car fans. These heaters are extensively used in overhead bunker cars and others of the

Canadian railroads. Control is provided by means of hand-operated dampers that can be reached from the ground. Another type of underslung charcoal heater used in this country in overhead bunker cars has ducts built into the car floor through which heated air is delivered to the loading space, through louvers at the ends of the car.

### Icing and Precooling Facilities

Icing facilities are provided at strategic loading points and major rail division points. These are so located that cars may be re-iced in transit about once every 24 hours. Many of these icing stations are equipped with mechanical icers (fig. 8) to speed up the process. Some of these stations are also equipped with machines for retop icing, both at point of origin and in transit.

Some railroads have facilities for precooling cars by means of trackside mechanical precoolers or by utilizing the cold air from ice-storage plants.

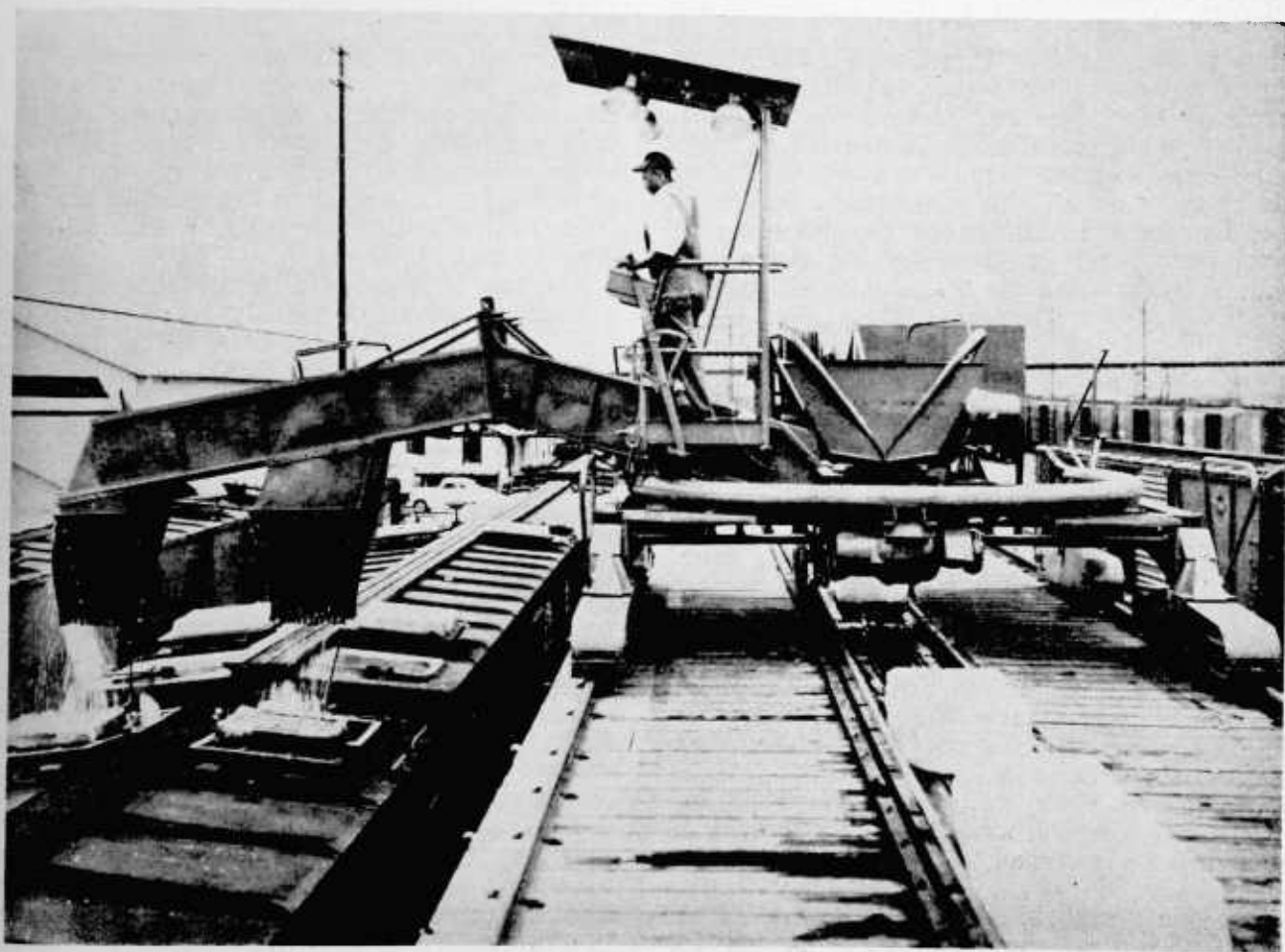


FIGURE 8.—Icing refrigerator car with mechanical icer.

### "Piggyback" Service

"Piggyback" service or trailer-on-flatcar operation is being widely employed in the movement of dry freight or merchandise by many rail and trucking interests. It has had limited acceptance thus far for transporting fresh fruits and vegetables although considerable interest is developing. In one type of operation, regular over-the-road trailers are driven onto special railroad flatcars and locked in position. In another operation special trailer bodies or containers are removed from the trailer chassis or special running gear and placed on the special rail flatcars. These special bodies or containers are similar in design to regular trailer bodies except for the fastening devices required.

Currently, mechanically refrigerated trailers and containers are generally being used in Piggyback service for perishable commodities.

Because of the difficulties of re-icing in transit, ice-bunkered vehicles have not been widely used for the service. While these mechanically refrigerated units are thermostatically controlled, merely setting the thermostat is not enough to insure desired transit temperature. Limited tests with Texas fruits and vegetables by the Market Quality Research Division have shown that, in heavy solid loads and with insufficient or no provision for air circulation around the load, cooling is unsatisfactory and uniform temperatures cannot be obtained. It is, therefore, important that both shippers and receivers realize that the same principles of air movement and temperature distribution apply to mechanically refrigerated trailers in Piggyback service as to over-the-road truck trailers or railroad refrigerator cars. Warm commodities should not be loaded into these vehicles without regard to the basic principles of good rail car or truck van loading (58).

### CONTAINERS AND LOADING

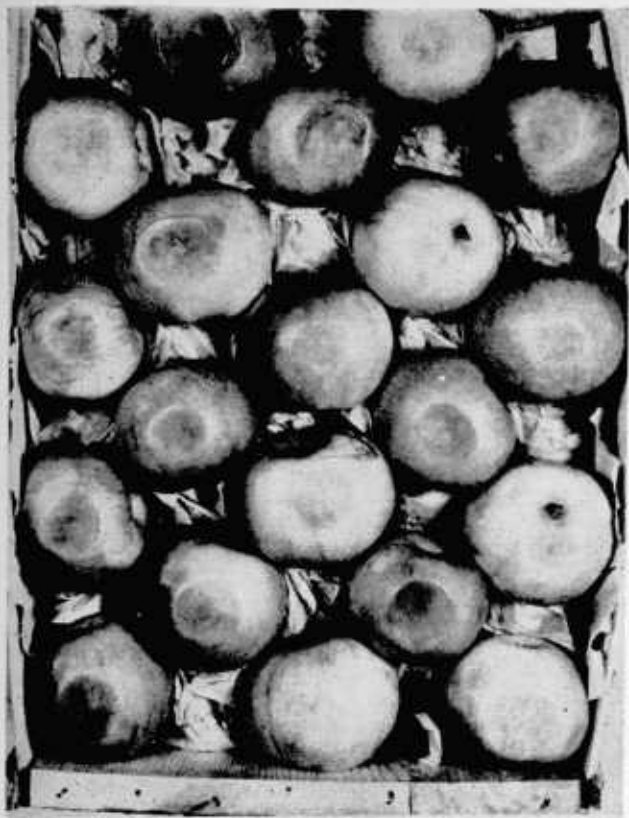
The selection and use of proper containers and the correct loading of these in the car are important factors in the distribution of fresh fruits and vegetables. Containers must protect the commodity, permit such heat exchange as necessary, and serve as an appropriate merchandising unit with sufficient strength to withstand normal handling. To avoid confusion and excessive cost, size and design should be standardized as much as possible. The material, dimensions, and construction of containers shipped by rail and the manner in which they may be loaded are governed by tariffs authorized by the Association of American Railroads (AAR) through its Freight Loading and Container Bureau in the various freight container tariffs (52-54, 131). Despite these rules, heavy transit losses occur through careless packing, handling, loading and unloading, improper load pattern, and rough handling of cars.

*Containers.*—The size, shape, and construction of containers are important for the protection of a given commodity (16). The containers should hold the desired quantity without causing pressure bruises or crushing from too tight a pack, or friction and abrasion injuries from a loose pack. If necessary the containers should be shaped to hold the commodity properly; for example, the pyramid-shaped asparagus crate. They must be strong enough to withstand weight of the upper layers of containers in a load, especially now with increased use of heavier loading. If cooling is required after packing, containers must have sufficient vent openings properly placed for rapid removal of heat.

Many commodities require liners or pads to prevent injury or bruising from contact with the container (fig. 9). Film liners are now used with some items such as cherries and pears to modify the concentrations of oxygen and carbon dioxide in the atmosphere and provide a high relative humidity (27, 44). Bananas are shipped with a polyethylene sleeve or shroud over each stem to minimize scarring from contact with car walls or with adjacent fruit in transit.

The use of fiberboard or corrugated cartons has increased tremendously in the past few years, with many commodities being packed in them almost exclusively (23). The principal factor in this rapid conversion from wooden containers has been the lower cost of cartons. With the growing trend to prepackage fruits and vegetables at production areas, fiberboard cartons will probably continue to be popular master containers for shipping the consumer packages. Until recently, it has not been practical to hydrocool or top ice cartons because of the damage to the fiberboard by wetting. Several manufacturers are now developing moisture-resistant corrugated materials that will permit these containers with proper vent holes to be exposed to hydrocooling water without weakening the containers. Some may be used with package ice and then top iced.

*Loading.*—A considerable amount of research by the railroads has been devoted to the proper loading of containers to minimize loss and damage in transit. The results may be found in the various Freight Container Tariffs. Under these rules, only authorized containers and



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FIGURE 9.—Apples showing typical flattened bruises produced by contact of box with car floor racks. Such injury can be largely prevented by use of appropriate cushion liners and careful handling of boxes.

methods of loading, proved by many tests and by actual use, may be used in loading perishables in refrigerator cars (fig. 10). However, new containers and loading methods may be tested by obtaining special permits from the railroads that handle the test shipment.

In a good load, containers must be placed so as to take advantage of their maximum strength and permit adequate stripping or use of spacers to hold the load in alinement (fig. 11). Necessary channels should also be maintained (142). Any slack in the load should be removed by the "squeeze" method when required, and appropriate braces used to prevent load shifting in transit (figs. 12 and 13). Regardless of methods used, close supervision of each operation is necessary to provide a load that will retain alinement. Kicking and dropping packages and walking on the load can result in much more damage to the commodity than normally occurs in a well-loaded car in transit.

Commodities shipped in bags should be protected by padding material on the floor racks. Breakage of baskets in transit is minimized by the use of the alternately inverted load (127). Sidewall flues or wall racks in cars are an excellent means of providing air circulation around a load but sometimes divert air which should be moving through the load. When loading any precooled commodity in hot weather, a door shield or tunnel should be used to prevent warming of the product and loss of refrigeration in a pre-iced car (fig. 19, page 43). Such protection is also required in very cold weather to prevent freezing damage (22). To minimize freezing damage in a car with no sidewall flues, containers (or bags) should be loaded compactly and away from contact with the car walls, as shown in figure 20, on page 44. Such clearance is particularly desirable in the bottom layers (figure 21, on page 45). Full advantage should be taken of the assistance provided by field representatives of the AAR Freight Loading and Container Bureau and the Freight Loss

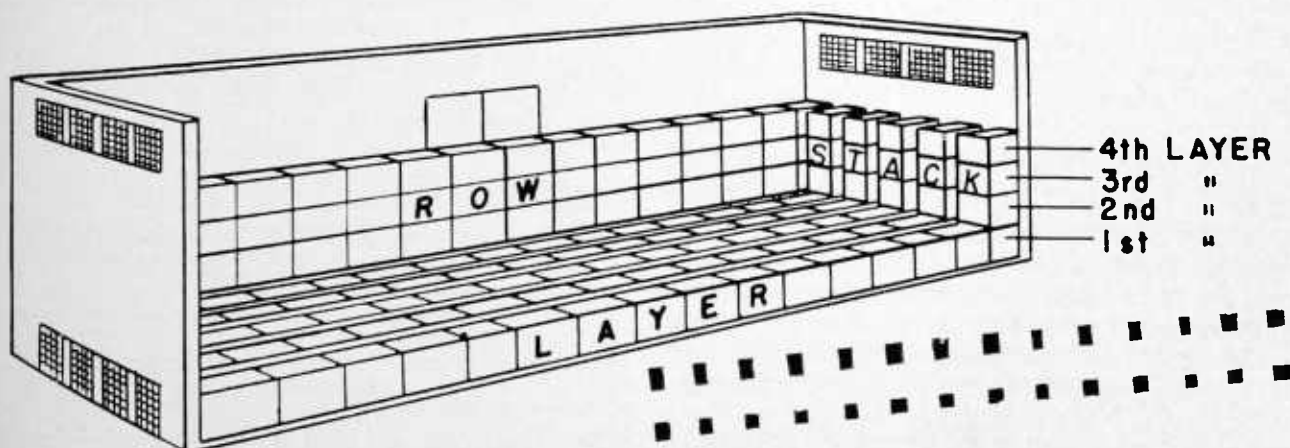


FIGURE 10.—Side view of load in a refrigerator car showing arrangement of containers in rows, layers, and stacks.

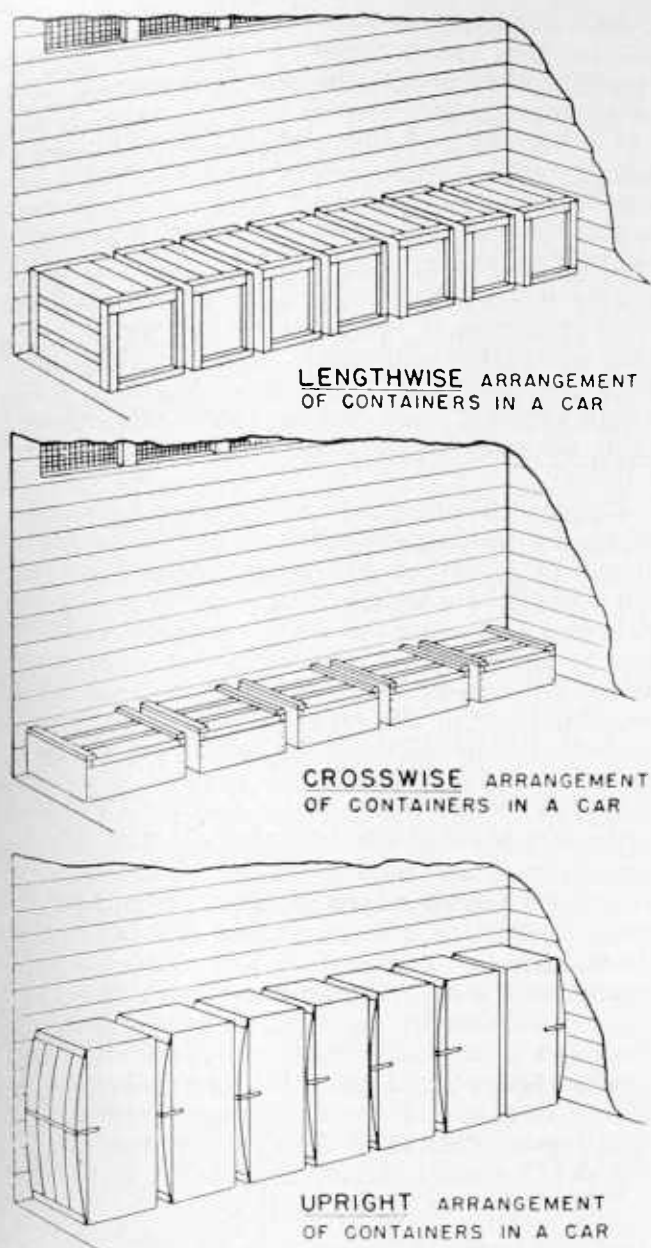


FIGURE 11.—Methods of placing containers in a refrigerator car.

and Damage Prevention Section. These organizations exist solely to reduce transit damage.

Heavier loading of many commodities in specified areas of the country has been stimulated by new incentive freight rates for larger than minimum loads and by per-car rates. This is resulting in lower per-package freight and refrigeration costs to the shipper and better utilization of rail equipment for the carriers (14). On the other hand, heavier loading usually means higher stacking in the car with

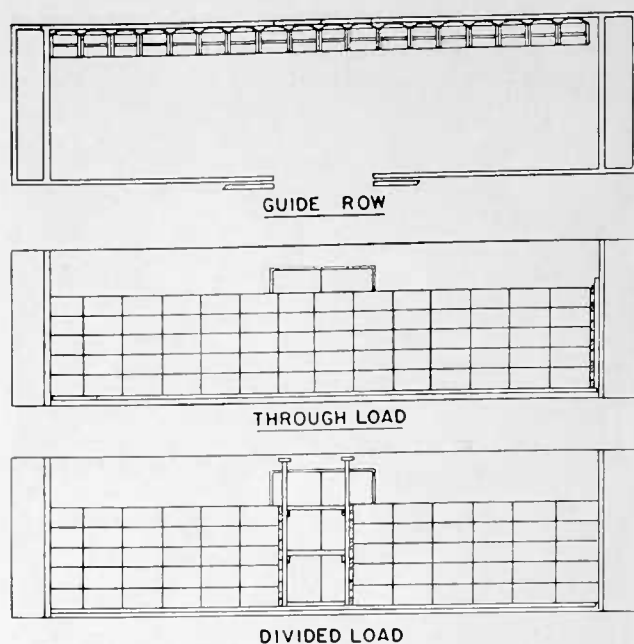


FIGURE 12.—The two general types of loads for refrigerator cars using a guide row to determine the number of stacks which can be loaded and amount of lengthwise space remaining to be taken up with a filler.

resultant increase in weight on bottom layers. This can result in crushing of weak containers and increased physical damage in bagged loads. Greater volume in the load may also mean changes in air circulation patterns and increases in the refrigeration required, especially in nonprecooled loads. Heavier loads, therefore,

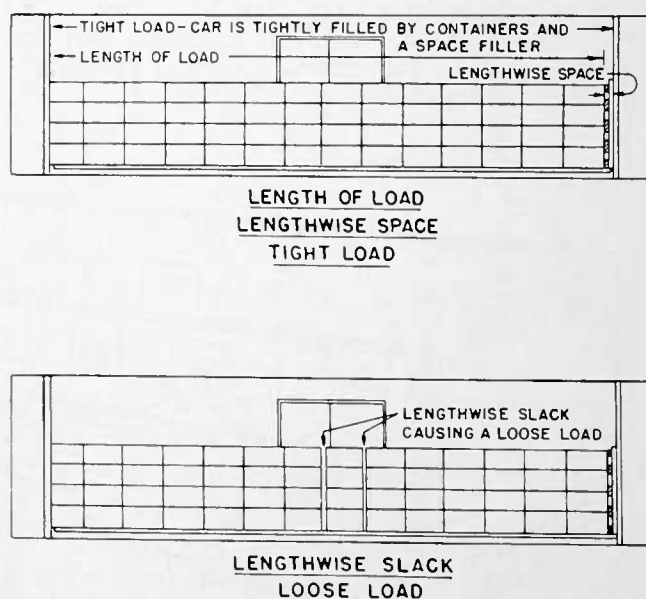


FIGURE 13.—Tight loads are necessary to minimize container damage in transit.

mean a reappraisal of protective services, especially in hot weather. To achieve the same temperature reduction during car precooling, it will be necessary to improve precooling efficiency or increase precooling time. It is important not to block the top bulkhead openings when a high load is used, as impaired air circulation may dangerously reduce the cooling rate. Fan cars must be used with heavier loads, particularly in very hot or very cold weather.

Limited information received on commodities from areas in which heavier loading has been used indicates that breakage has not been seriously increased thus far. Even in 50,000-

pound loads of potatoes in 100-pound burlap bags or in consumer-size paper bags, bruising in the bottom layers has increased only slightly. In some instances, customary refrigeration services for normal, lightweight shipments have appeared to be adequate for heavier loads, mainly with precooled commodities. However, for heavier loads of commodities loaded at high temperatures in hot weather, the maximum protection service recommended for ordinary sized loads should be selected. For Texas tomatoes, the protective services needed for heavier loads and different types of containers are included in table 9.

## PROTECTIVE SERVICES AVAILABLE

### General Definition of Perishable Protective Service Rules

The various rail protective services appearing in this handbook and the designated rule numbers are based in general on information provided in Perishable Protective Tariffs and supplements thereof. These tariffs are No. 18 issued by the National Perishable Freight Committee (55) and No. 27 prepared by the REA Express. Many other kinds of protective services provided in the tariffs do not particularly apply to the services recommended in the handbook and they are therefore omitted. The tariffs also include charges assessed for the various protective services offered, based on origin and destination of the shipment, but such charges are not within the scope of this handbook.

The rules included in the handbook apply to carlot shipments of fresh fruits and vegetables having both origin and destination within the United States. They also cover certain agricultural commodities originating in Canada, Cuba, or the Republic of Mexico, but only from the first point in the United States through which such shipments pass, to points in the United States.

A further discussion on the use of the protective services is included in the section headed "Methods of Controlling Transit Environment." There are three general types of protective service: Refrigeration, ventilation, and heating service.

Refrigeration is by three general methods: bunker icing, body icing, and mechanical.

Ventilation is also of three general types: Standard, Special, and Combination.

Heating service for other than mechanical cars comes under four general categories: Carriers' Protective Service, Shippers' Protective Service, Shippers' Specified Service, and Special Heater Protective Service. There are also Modi-

fied Carriers' Protective Service and Voluntary Heater Service, but neither of these apply to the various classes of protective service outlined in the handbook.

Heating is also possible in mechanical refrigerator cars. It is accomplished by thermostatically controlled reverse-cycle refrigeration or by heating elements contained in the mechanical unit. This type of service comes under Rule 700 (Mechanical Protective Service), which is not defined herein. Following is a general explanation of the tariff rules shown.

### Perishable Protective Tariff 18

#### Refrigeration service

*Rule 200, "Application."*—Only sections (K) and (L) of this rule are referred to in the handbook. They provide for different compulsory refrigeration services during certain periods on potatoes (other than sweetpotatoes or yams) from Idaho Groups B and C, Oregon Group B, and Washington.

*Rule 201, "Standard Refrigeration Service."*—Involves pre-icing or initial icing of car bunkers and re-icing to capacity at all regular icing stations in transit. On vegetables moving under half-stage Standard Refrigeration Service without ice on top of the load, the shipper may instruct on the bill of lading that if the car is held at stop, hold, or reconsigning point, or while at destination, it should be re-iced to capacity daily, regardless of the amount of ice in the bunkers. However, the car will not be re-iced at destination if the *consignee*, after accepting the shipment, instructs the carrier, "Do not re-ice." Cars may be loaded dry and iced thereafter, depending on available icing facilities and kind of commodity.

*Rule 202, "Furnishing of salt."*—Certain percentages or quantities of salt are added to the ice to produce lower air and commodity tem-

peratures in car. The salt may be supplied at pre-icing, initial icing, replenishing, or one or more re-icings, in transit, also during precooling operations as ordered by the shipper. When a certain percentage of salt is specified, this means the ratio of salt to quantity of ice supplied.

*Rule 237, "Cooling cars at origin."*—Pertains to shipments of cucumbers, pineapples, potatoes (other than sweetpotatoes or yams), and tomatoes, from certain States in the Eastern, Southern and Southwestern territories as shown in the tariff. The rule, however, does not apply to potato shipments originating at stations on certain Southwestern railroads specified in the rule. The rule is applicable to shipments that are initially iced by the carrier or shipper with not more than 5,000 pounds before completion of loading, and are then transported from the loading station to destination under Standard Ventilation. The shipper must show on the bill of lading that car was so cooled at origin, state the amount of ice that was supplied, and indicate that the shipment is to be handled in transit under Standard Ventilation. When a shipment originally transported under the provisions of this rule has the service changed to *icing in transit*, the additional charge will be on the basis indicated in the rule. This rule also applies to shipments of potatoes (other than sweetpotatoes or yams) originating on one railroad in Maine, when the railroad absorbs the cost of initial icing not to exceed 5,000 pounds.

*Rule 239, "Citrus fruits from Arizona and California preiced and replenished by carrier."*—Applies to icing operations and certain other refrigeration and ventilation services which the shipper may desire in connection with this rule. The shipper must specify on the bill of lading whether or not the car is to be re-iced following replenishing of the ice bunkers by the carrier. If one to three re-icings in transit are ordered, the shipper must specify on the bill of lading at what regular icing stations the service is to be furnished. The tariff provides stated charges from origin to destination. If, upon subsequent instructions, the shipment is re-iced more than *three* times before arrival in destination terminal train yard, the shipment will be placed under Standard Refrigeration Service at point of fourth re-icing. The overall charge, including this change in service, will be on the basis indicated in paragraph G of the rule.

Upon written instructions, ventilation in conjunction with this rule will also be furnished on basis of the charge applicable from origin to destination, as provided in paragraph D, but without nullifying the charges provided for in

the rule if the shipment is re-iced after ventilators are opened. Also, if, upon instructions, the vents are opened at any time after the car has left the loading station and the car is later re-iced, it will be transported under Standard Refrigeration Service from point of first re-icing after opening of the vents, with ensuing charges as in paragraph J of the rule.

*Rule 240, "Handling shipments billed, Initially iced; do not reice."*—Involves shipments initially iced by carrier or shipper before or after loading with no re-icing in transit. Also applies to shipments pre-iced by the carrier and replenished by the *shipper*, with no re-icing in transit. When a shipment is forwarded in an uniced refrigerator car, the carrier will, upon reasonable advance written notice, initially ice the bunkers at a regular icing station in transit. If the car cannot be iced at the designated station, the change in service will be made at the first available regular icing station. If a car originally billed "do not re-ice" under this rule, upon subsequent instructions, has the bunkers re-iced before arrival in destination terminal train yard, it shall be handled under Standard Refrigeration Service from point of re-icing to destination, except where other refrigeration services are provided as referred to in exceptions 2 and 3 of the rule.

If ventilation is desired in conjunction with refrigeration service provided by this rule, the shipper must specify the class of ventilation service. Such ventilation shall not require the removal of ice from the car bunkers, nor nullify the charges provided in this rule.

On shipments of potatoes (other than sweetpotatoes or yams) originating at stations in Idaho Groups B and C, Oregon Group B, and Washington, during certain periods, the compulsory refrigeration provisions of paragraphs K and L of Rule 200 will apply.

*Rule 242, "Top or body icing service, Western Territory."*—Applies to shipments of fruits, berries, melons, and vegetables originating in States (or at certain stations) specified in the tariff. Although the rule caption includes reference to fruits and berries, top icing does not seem to be practicable for these two commodities and apparently is not being used. The service consists of the placing of specified amounts of ice in the body of car by the shipper (exclusive of ice in the packages), usually on top of the load. This rule also applies where block ice is placed on floor racks, in the centerline channel of the load. The shipper must specify on the bill of lading the net quantity of ice used in top or body icing. If *initial* top ice is to be supplied in transit at certain stations authorized by the rule, the shipper must instruct the carrier as to the amount. If

the amount of top ice supplied to the car exceeds certain permissible maximum amounts specified in the rule, the excess ice will be transported at the freight rate applicable to the lowest rated commodity in the car.

The shipper is permitted to supply 5,000 pounds or less of top ice for precooling melons from all origins, or vegetable shipments originating in Arizona, California, and Texas. The ice must be either entirely consumed during precooling or removed from the body of the car before transit movement. Whichever of these disposals of top ice occur must be shown on the bill of lading by the shipper.

If any ventilation service is desired in connection with top-iced shipments, the shipper must specify the class of ventilation on bill of lading.

*Rule 243, "Top or body icing service, Eastern and Southern Territories."*—This rule applies only to vegetables and *preserved* berries, in the Eastern and Southern territories. Top-icing methods, also data or instructions to be furnished by the shipper, correspond in general to provisions in Rule 242.

*Rule 245, "Citrus fruits, precooled, originating in Arizona and California."*—Applies to citrus shipments originating in California and precooled by the carrier at stations where carrier's precooling plant is located. This involves cars pre-iced, precooled, and replenished by the carrier; cars precooled by carrier and afterwards initially iced by carrier; and uniced cars precooled by the carrier and, upon request of shipper, forwarded without ice through to destination under instructions "Do not ice." The rule also covers citrus shipments originating in Arizona and California and precooled by the shipper in a regularly established cooling plant and loaded into a car pre-iced by the shipper at the station where the cooling plant is located.

Whichever icing and precooling procedure is selected must be specified by the shipper on the bill of lading. Pre-iced or initially iced cars may be re-iced in transit once, twice, or three times, subject to stated charges from origin to destination. The shipper must also show whether or not the car is to be re-iced in transit, and the stations at which re-icing is to be done. If a car, upon instructions, is re-iced more than three times before arrival at destination terminal train yard, the shipment will be transported under Standard Refrigeration Service from point of fourth re-icing, except as provided under paragraph I of the rule. The overall charge including this change in service will be as indicated in paragraph H of the rule. If, upon written instructions, the car is moved with vents open at any time after being ini-

tially iced and is later re-iced, the shipment will be transported under Standard Refrigeration Service from point of first re-icing after opening of the vents. The overall charge including this change in service will be defined in paragraph I of the rule.

*Rule 246, "Cooling in car by shipper."*—Pertains to precooling of shipments by the shipper in iced or uniced cars within the States specified in the rule, by mechanically operated fans or other device during or after loading. The precooling charges specified in the rule are not applicable when the lading is precooled by vacuum cooling or hydrocooling, when the method of precooling does not utilize the ice in car bunkers, when the car is initially iced by the shipper, or when shipper elects to re-ice the bunkers at his own expense after precooling. Shipments may be cooled in the car by the shipper during transit movement, under the conditions outlined in paragraphs A, E, and F, part 2, of the rule subject to additional charge for ice consumed in cooling. The shipper must show on the bill of lading certain details of precooling in car at loading point, advice if the lading was vacuum cooled or hydrocooled, and instructions if shipment is to be cooled in car at some station in transit. Cooling of lading in the car at destination by the consignee is permissible on private siding or public delivery track where facilities are available, with use of portable or car fans operated at the consignee's expense.

*Rule 247, "Fruits, berries, vegetables, melons and other perishable freight, reiced in transit."*—Applies to shipments from the States and Canadian provinces designated in the rule, which includes all Western States and four Eastern States. The shipments affected are those which are originally billed to re-ice a specific number of times in transit. The shipper must show on the bill of lading the number of times the car is to be re-iced, and at what regular icing stations. Stated charges apply from origin to destination. If a shipment is originally billed to re-ice once in transit under part 1 of the rule, or to re-ice twice in transit under part 2, or to re-ice three times in transit under part 3, but upon subsequent instructions is re-iced oftener than originally indicated before arrival at destination terminal train yard, it will be placed under Standard Refrigeration Service from point where the first additional re-icing occurred. The overall charge including the change in service will be as in paragraphs B of part 1, F of part 2, and E of part 3 of the rule.

If, upon instructions, the vents of the car are opened at any time after initial icing and the car is later re-iced, Standard Refrigeration

Service will apply from point of first re-icing after opening of the vents (certain exceptions are made). Charges in this connection will be as indicated in paragraphs G of part 1, K of part 2, and J of part 3.

On shipments of potatoes (other than sweet-potatoes or yams) originating at stations in Idaho Groups B and C, Oregon Group B, and Washington, during certain periods, the compulsory provisions of paragraphs K and L of Rule 200 will apply.

*Rule 248, "Retop icing by carriers."*—Consists of retop icing in transit by the carrier, at stations designated by the carriers as retop-icing stations, of shipments of vegetables that were originally top iced by the shipper. Also applies to shipments of melons retop iced by the carrier at final destinations designated by the carrier, if so ordered by the consignee. The shipper must show on the bill of lading the amount of top ice that was supplied to the car at origin, and also specify at what icing station the car is to be retop iced, and with what amount of ice. A charge per ton is assessed for ice supplied.

*Rule 251, "Citrus fruits, deciduous fruits, pineapples, vegetables and frozen berries, also canned goods (not frozen) from Florida Group "B" reiced once in transit."*—Applies to precooled or nonprecooled shipments originating at stations in Florida (Origin Group B) which are initially iced by carrier before or after loading and re-iced only once in transit. Stated charges apply from origin to destination. However, if the shipper changes the instructions and the car bunkers are re-iced more than once before arrival in destination terminal train yard, the shipment will be transported under Standard Refrigeration Service from point of second re-icing. The rule further provides that the carrier will accept "change in service" instructions to re-ice once in transit a shipment that was initially iced by the carrier or shipper and originally forwarded under instructions to "initially ice, do not re-ice" (Rule 240).

When either a precooled or a nonprecooled shipment is forwarded with bunkers dry or without ice, the carrier will, upon reasonable advance notice, place the shipment under refrigeration in transit to the extent of initial icing and one re-icing, at regular icing stations designated by the shipper. The shipper must show on the bill of lading whether or not the shipment was precooled at point of origin, and indicate at what regular icing station (or stations) the car is to be initially iced or re-iced.

If ventilation is desired in conjunction with refrigeration service, the class of ventilation and when or where it should be performed must also be specified by the shipper. Such

ventilation, however, shall not be construed as requiring removal of ice from car bunkers.

*Rule 252, "Citrus fruit and vegetables from Florida Group "B", initially iced by the shipper and reiced once in transit by the carrier."*—Pertains to shipments from Florida, pre-iced or initially iced by the shipper, and re-iced only once in transit. This rule also applies to shipments which originally moved under Rule 240 ("initially iced, do not re-ice"), but the service was changed en route to re-ice once in transit on instructions from shipper. Stated charges apply from origin to destination.

If ventilation is desired in conjunction with the refrigeration service covered by this rule, the shipper must specify the class of ventilation service on the bill of lading. If one or more vents of the car are open at any time between initial icing and re-icing, an additional charge will be assessed the shipper.

*Rule 254, "Fruits, berries, vegetables and melons preiced and replenished by carrier."*—Pertains to shipments from the Western territory, Louisiana, and some Middlewest areas (except citrus from Arizona and California) which are pre-iced and replenished by the carrier. Shipments may be forwarded without re-icing or with one re-icing in transit, or from certain origins on specified commodities with two or three re-icings in transit. Stated charges apply from origin to destination.

The shipper must specify on the bill of lading what re-icing, if any, is to follow replenishing of ice bunkers, and at what regular icing stations. Any additional re-icing or icing service in transit besides that provided for in paragraphs C1, C2, C3, and C4 (or in addition to that originally ordered on the bill of lading), before arrival at destination terminal train yard, will result in change to Standard Refrigeration Service from point where the additional re-icing occurred. The overall charge, including the change in service, shall be as defined in paragraph G of the rule. If, upon written instructions, the vents are opened after car has departed from the loading station and the car is later re-iced, it will be transported under Standard Refrigeration Service from point of first re-icing after opening of the vents, on the basis of charges indicated in paragraph J of the rule.

On shipments of potatoes (other than sweet-potatoes or yams) originating at stations in Idaho Groups B and C, Oregon Group B, and Washington during certain periods, the compulsory provisions of paragraphs K and L of Rule 200 will apply.

*Rule 255, "Half-stage refrigeration service."*—This means using only the upper portion of the car bunkers for icing. In cars equipped for

this service, the ice grates are raised to a point approximately midway between the top and bottom of the bunkers. The service will be supplied by the carrier only when refrigerator cars equipped for half-stage icing are available at origin. When a shipper desires a car of this type, he must so specify when the car is ordered. It is also necessary for him to indicate on the bill of lading "Half-Stage Refrigeration Service." The service does not apply to shipments originating on some railroads and in certain areas of the South (such as mentioned in subparagraph 2 of paragraph A of Rule 258) when the car is initially iced by the shipper. If a shipment is loaded in an uniced half-stage-equipped car the carrier will, upon instructions, place the shipment under half-stage refrigeration service at a regular icing station in transit. This, however, applies only when the point of origin and the specified regular icing station are both located in the States or at the stations shown in the tariff under paragraph A, note 1, of this rule.

On shipments of potatoes (other than sweet potatoes or yams) originating at stations in Idaho Groups B and C, Oregon Group B and Washington, during certain periods, the compulsory provisions of paragraphs K and L of Rule 200 will apply.

#### Ventilation service

*Rule 385, "Shippers' instructions and waybill notations."*—Part of this rule provides instructions for ventilation service for refrigerator cars. This is the manipulation of ventilating devices (hatch covers and plugs) of car bunkers to permit or prevent passage of the outside air to car interior. The rule is divided into three parts: Part 1, Standard Ventilation; part 2, Special Ventilation; and part 3, Combination Ventilation (combination of parts 1 and 2). Standard Ventilation is the manipulation of vents at certain temperatures as prescribed in the rule, Special Ventilation is the manipulation of vents at temperatures or stations specified by the shipper, and Combination Ventilation is the use of both Standard and Special Ventilation, each on a portion of the route. The carrier will also accept instructions to keep the vents closed throughout entire handling of the shipment.

These classes of ventilation service vary with the kind of commodity, the geographical location of shipping point, and the time of year. Cars moving under any class of ventilation service will not have vents adjusted between regularly assigned inspection points, except when trains are delayed, when attention will be given as soon as practicable. When the shipper requests adjustment of vents at a place which

is not a regular inspection station, the vents will be adjusted at the first regular inspection point beyond. The shipper must specify on the bill of lading the class of ventilation desired.

#### Protective service against cold (heater service)

*Rule 510, "Shippers' Protective Service."*—Protection against frost, freezing, or artificial overheating will be provided by the proper use of heaters furnished, initially fueled at origin, and installed by the shipper. The heaters will be subsequently serviced by the carrier as the shipper directs. (The service, however, will not be performed on a few eastern railroads listed under part 2 of the rule.) The heaters must be of suitable design as to safety, in proper operating condition, and securely fastened to the bunker or bunkers. There must be no hay, straw, or other combustible material in the bunkers. Shipments will be transported under this rule solely at the owner's risk of damage by heat or cold not the result of carriers' negligence.

Parts 1 and 3 of the rule cover commodities such as liquids, preserves, and canned goods, on which the service is available from October 15 to April 15 inclusive. Part 2 of the rule applies from November 16 to March 31, inclusive, on shipments of fresh vegetables originating in the New England States and moving to destinations in Heater Territory, part 2; stations in Illinois on certain railroads; also stations outside of Heater Territory in the Southeast, as indicated in the tariff.

If LF heaters (thermostatically controlled alcohol heaters) are used, the shipper must light the pilot of the heater or heaters when they are installed. The shipper or his agent will also light charcoal and underslung heaters before the loaded car is tendered to the originating carrier, if the outside temperature is at or below the minimum specified by the shipper. The shipper must show on the bill of lading the heater numbers, also when or at what temperatures portable charcoal and underslung heaters are to be lighted and extinguished; also the temperature at which each LF heater thermostat is set. In the absence of shippers' instructions, the heaters will not be serviced. The rule further provides that the vents of refrigerator cars will be kept closed from origin to destination.

*Rule 514, "Shippers' Specified Service."*—Protection against frost, freezing, or artificial overheating will, upon reasonable advance notice, be supplied by proper use of heaters furnished, installed, and serviced by the carriers as directed by the shipper, within the territory described in paragraph L, part 1, of the rule. The rule further provides that the carrier will

furnish heater or heaters for preheating of cars, or for heating while cars are in process of loading. On shipments destined to points beyond territory covered by paragraph L, heater service will, upon specific request of the shipper, be continued to stations in certain Southern States as mentioned in paragraph M of the rule. On shipments arriving at Florence, S.C., the heater or heaters will be removed by the carrier, unless otherwise instructed.

The rule applies in general to portable or underslung charcoal heaters but part 3 of the rule also provides for the use of LF heaters (subject to the provisions of part 1) in shipments of tomatoes originating in Arizona, California, Texas, and Mexico. The shipper must specify the number of heaters required and the outside temperatures at which each charcoal heater is to be lighted and extinguished, also the temperature at which heater thermostat should be set on LF heaters. The shipper must also designate the class of ventilation desired in conjunction with such heater service; otherwise the vents will be manipulated on basis of Standard Ventilation, except that commodities listed in paragraph B of Rule 320 will be transported with vents closed. Service under this rule is available from September 1 to May 31 inclusive.

*Rule 515, "Carriers' Protective Service."*—Requires that the carriers will protect the shipment within Heater Territory, against frost, freezing, or artificial overheating, furnishing artificial heat or such other protective service as may be necessary. This service is available throughout the heater season, from October 15 to April 15 inclusive, and is subject to stated charges per car for the movement within Heater Territory. It is compulsory within Heater Territory on shipments of potatoes (other than sweetpotatoes and yams) originating in Heater Territory, part 1, from November 16 to, but not including, March 1. Portable charcoal, underslung, or LF heaters may be used. If the shipper desires car vents to be kept closed in transit, he must so specify on the bill of lading.

In the absence of instructions as to class of service beyond Heater Territory, the shipment will be transported under Standard Ventilation, except commodities covered by paragraph B of Rule 320. Carriers' Protective Service will be furnished in the Provinces of Ontario and Quebec on shipments which are moving under this class of service from points in the United States, when destined to points in the United States via routes through Canada. Paragraph F of the rule provides exceptions on certain commodities and areas on certain railroads where this service does not apply.

*Rule 519, "Shippers' Specified Service on pineapples (see rule 105) or tomatoes."*—Applies only while shipments are being held. Protection against frost, freezing, or artificial overheating will be supplied by proper use of heater or heaters furnished, installed, and serviced by the carriers as directed by the shipper, in shipments of pineapples or tomatoes held at stations within Heater Territory, part 1. The rule also applies to tomato shipments held at stations outside of Heater Territory, part 1, west of the Mississippi River.

The shipper must instruct the carrier as to when the heater or heaters are to be installed, lighted, extinguished, and removed. The shipper must also designate the temperature setting desired for the thermostat on LF heaters. The service is subject to a charge per heater day. The shipper must also specify the class of ventilation service required, otherwise the vents will be kept closed.

The service is available between January 1 and December 31 inclusive. It is furnished solely at the owner's risk of loss or damage from heat or cold not the result of negligence of carrier.

*Rule 520, "Shippers' Specified Service with LF heaters."*—Protection against frost, freezing, or artificial overheating in shipments of tomatoes or pineapples from Florida will be supplied by use of LF heater or heaters furnished, installed, and serviced by the carriers, as directed by the shipper. When available, the heaters will be furnished at certain stations in the South, also at Potomac Yard, Va., and Jersey City, N.J. If LF heaters are not available at the station specified by the shipper, they will be furnished at the next station en route where such heaters are obtainable. If a shipment moves via more than one carrier, the carrier supplying the LF heater or heaters is not obliged to permit them to move beyond its own line. Servicing of the heaters will be available on certain railroads within a number of States in Heater Territory, parts 1 and 2, and within a few specified areas in the South. If the shipment moves beyond these specified territories, it will be handled under Standard Ventilation, unless the shipper files specific instructions to the contrary.

The shipper must specify the number of heaters required, and the temperature at which the thermostat of each is to be set. The carriers will, upon instructions, remove the heater or heaters while the car is being held at an intermediate point or at destination. If ventilation is desired in conjunction with such heater service, the shipper must specify the temperatures at which the car vents are to be opened and closed; otherwise the vents will be manipulated

at the same temperature as specified for heater thermostat setting. The service is available from September 1 to May 31 inclusive, and is subject to a charge per heater day.

*Rule 580, "Special Heater Protective Service."*—Protection against frost, freezing, or artificial overheating on perishable freight will be supplied by the use of LF heater or heaters furnished, installed and serviced by the carriers as directed by the shipper. The service applies to shipments originating in Special Heater Protective Service Territory or on the railroads specified in the rule. The service will be provided from origin or from first terminal train yard where LF heaters are available, to final destination *within* or to *point of exit* from Special Heater Protective Service Territory, subject to stated changes per car. However, the rule provides that, on certain railroads in the Northwest, shipments which originate at stations where LF heaters are not available will have the service under this rule performed with charcoal heaters from origin to first *regular* heater inspection station. LF heaters will be substituted at that station.

Upon reasonable advance notice, the carrier will substitute the heater service covered by this rule (within Special Heater Protective Service Territory) for refrigeration service, ventilation service, or one of the other classes of heater service referred to in paragraph B-1 of the rule. The shipper must designate where in transit the change in service is to be made.

The bill of lading must show at what temperature the thermostat of LF heaters should be set. If ventilation is desired in conjunction with heater service, the shipper must also specify on the bill of lading that the vents either be kept closed to destination, or adjusted at the outside temperatures he designates. In the absence of instructions from the shipper as to how the vents are to be manipulated, they will be adjusted at the same temperature specified for setting of the heater thermostat. When the shipment moves beyond the territory covered by this rule, it will be handled under Standard Ventilation unless the shipper files specific instructions to the contrary. However, the rule does specifically provide that shipments of *avocados* or *limes* and commodities listed in paragraph B of Rule 320 in the tariff will be handled with the vents *closed*, unless the shipper instructs to the contrary. Service under this rule is available from September 15 to May 15 inclusive.

#### Explanation of heating service terms

"Standard Heating in Canada" applies only on the Canadian Pacific Railway and Canadian National Railways to shipments originating

within or outside the Heater Territory in the United States and destined for Canada or moving through Canada to destinations in the United States (15). Standard Heating provides for use of two portable heaters, one placed in each bunker of the car, to be lighted or extinguished at temperatures shown for various perishable commodities in the tariff. Should the shipper not desire to forward the car under the regulations of Standard Heating, he may specify outside temperatures at which he requires the heater or heaters to be lighted or extinguished. The shipper must specify the number of heaters required, also what manipulation of car vents is desired.

The term "LF heaters," used in Perishable Protective Tariff 18 and mentioned in the foregoing definitions of heater service rules, means thermostatically controlled liquid fuel (alcohol) heaters.

Official Heater Territory, parts 1 and 2, also Shippers' Specified Service Territory as referred to in Perishable Protective Tariff 18 and in the heater service rules defined above, are shown in the maps in figures 32 and 33 on pages 60 and 61.

### REA Express Perishable Protective Tariff 27

*Rule 1, "Regulations governing refrigeration."*—Has reference to tariff charges for refrigeration and the importance of clearly showing all icing instructions on the waybills.

*Rule 4, "Salt."*—Pertains to use of salt and charges therefor, when supplied to car bunkers at point of origin or in transit. The shipper must specify what percentage of salt is desired, and when or at what icing station it is to be supplied by the REA Express.

*Rule 5, "Precooling service."*—Applies to carlot shipments placed in pre-iced cars at point of origin and precooled by the shipper with the use of precooling apparatus during or after loading. This rule further provides that shipments, subject to delay, may be cooled in the car by the *shipper* at a point in transit in direction of movement to destination, but not beyond first regular re-icing station. If the shipper elects to re-ice the bunkers to full capacity after precooling apparatus has been removed from the car, no precooling charge will be assessed. There also will be no charge for precooling service if the method or device used for precooling does not utilize the car bunkers or the ice contained therein.

This rule also provides for the top icing at point of origin of melon shipments from Arizona and California, with not more than 5,000

pounds of ice, provided all of the ice is consumed during cooling or is removed from the car body before release of the car.

*Rule 15, "Modified refrigeration service."*—This rule, under separate paragraphs, provides for different icing services or combinations thereof. Included are initial icing by the REA Express or shipper with no re-icing or only one re-icing in transit, and shipments originally

forwarded in dry cars (no ice in the bunkers) but initially iced somewhere en route. In each of the above instances, the shipper must specify a regular icing station at which the one re-icing or initial icing in transit is to be performed. This rule also covers shipments which are re-iced more than once in transit, or are re-iced in transit after having been originally forwarded under instructions not to re-ice.

## FACTORS AFFECTING POSTHARVEST LIFE OF FRESH FRUITS AND VEGETABLES

Fruits and vegetables are living organs, even though separated from the plant. The intent during marketing is to maintain freshness and other characteristics of quality (79). Deterioration in fresh produce is caused chiefly by aging, decay, functional disorders, moisture loss, mechanical injury, physical injury, and to a lesser extent insect and chemical injuries. Quality is maintained by careful control of these deteriorative influences.

Because fruits and vegetables are alive, they breathe or take in oxygen and give off carbon dioxide. In this process, known as respiration, fruits and vegetables give off heat which is commonly measured in B.t.u. (British thermal units) (30). The heat given off through respiration is known as vital heat. It varies with different fruits and vegetables as shown in table 1. There is a direct relationship between the rate of respiration and the perishability of a commodity; therefore, vital heat production may be taken as a measure of perishability. Heat of respiration has a definite effect on refrigeration requirements during transit. This will be discussed in a later section on methods of controlling transit environment.

### Temperature

As life processes are essentially chemical reactions, their rate is affected by temperature. Therefore, high commodity temperatures accelerate the rate of respiration of fruits and vegetables, resulting in more rapid ripening and aging. Refrigeration is used to slow the life processes of the fresh commodity as much as possible without interfering with its normal metabolism. As an illustration, spinach is a very perishable vegetable and has a very high respiration rate which, even at 32° F., produces 4,550 B.t.u. per ton per day. At 40°, this rate is doubled and at 50° it is 4½ times as great as at 32°. This emphasizes the importance of rapid removal of field heat after harvest to preserve quality and extend shelf life of the commodity. In general the respiration rate of fresh fruits and vegetables practically doubles

for each 10-degree rise in temperature. Highly perishable products such as spinach and strawberries must be moved quickly and maintained at low temperatures all the way to the consumer (64).

In contrast to leafy vegetables such as spinach, many fruits, roots, and tubers with low respiration rates are relatively long lived. As an example, the apple has a low respiration rate. It produces only about 900 B.t.u. per ton per day at 32°, which is about one fifth of that for spinach at the same temperature. Under proper refrigeration it has a long storage life (up to 9 months at 31°–32°).

While low temperatures (32° to 40° F.) are desirable for many crops, some commodities such as tomatoes, bananas, and lemons are injured by low temperatures. Chilling injury to tomatoes results in their failure to ripen properly, with consequent poor flavor and appearance, also extensive decay (75, 76). Bananas which have been chilled fail to ripen properly and become discolored (3). Chilling of lemons causes various types of rind breakdown or internal browning (110). It is, therefore, imperative that such commodities be held at moderate temperatures. A safe or desirable range of transit temperatures for most of the important horticultural crops is given in table 3 on page 24, in the section headed "Commodity Requirements." A more detailed discussion of other special requirements for these crops is contained in the same section.

### Moisture

The quality of fruits and vegetables is also affected by the amount of moisture in the air surrounding them in transit. A high relative humidity, about 90 percent, is desirable for most commodities to prevent wilting or moisture loss. Humidity in both iced and mechanically refrigerated cars is usually high. Low humidities may sometimes be encountered in dry-car (no ice) shipments, moving under ventilation. Top ice and package ice used for some commodities, especially the leafy vegetables,

TABLE 1.—*Approximate rate of evolution of heat (heat of respiration) by certain fresh fruits and vegetables at the temperatures indicated*  
[B.t.u. per ton per 24 hours]

Commodity	32° F.	40° F.	60° F.	80° F.	Source of data
<i>Fresh fruits</i>	<i>B.t.u.</i>	<i>B.t.u.</i>	<i>B.t.u.</i>	<i>B.t.u.</i>	
Apples.....	900	1,625	5,075	-----	(145)
Avocados.....	-----	-----	-----	-----	(1)
Bananas <sup>2</sup> .....	-----	-----	-----	-----	(145)
Cherries, sweet.....	1,250	-----	-----	-----	(145)
Citrus:					
Grapefruit <sup>3</sup> .....	660	1,015	3,090	-----	(145)
Lemons.....	690	1,255	3,630	5,010	(145)
Oranges.....	725	1,430	4,410	-----	(145)
Cranberries <sup>4</sup> .....	660	920	-----	-----	(145)
Grapes:					
American type.....	602	1,170	3,487	8,481	(145)
Vinifera.....	365	-----	2,410	-----	(145)
Peaches.....	1,110	1,735	8,285	20,200	(145)
Pears.....	770	-----	11,000	-----	(145)
Plums, Wickson.....	540	1,200	2,600	-----	(18)
Strawberries.....	3,265	5,180	17,960	41,830	(145)
<i>Fresh vegetables</i>					
Asparagus.....	8,300	14,000	32,000	-----	(67)
Beans, snap.....	5,830	10,275	38,110	-----	(145)
Beets (roots).....	2,650	4,060	7,240	-----	(145)
Broccoli (sprouting).....	7,450	14,300	41,900	-----	(145)
Cabbage.....	1,200	1,670	4,080	-----	(145)
Carrots (roots).....	2,130	3,470	8,080	-----	(145)
Celery.....	1,620	2,420	8,220	-----	(145)
Corn, sweet.....	6,560	9,390	38,410	61,950	(145)
Cucumbers.....	1,690	2,550	10,460	-----	(145)
Lettuce, head.....	2,640	3,500	9,200	-----	(89)
Melons:					
Cantaloups.....	1,320	1,960	8,500	-----	(145)
Honeydew.....	-----	900	3,100	-----	(87)
Onions, dry <sup>5</sup> .....	880	-----	-----	-----	(145)
Peas, green.....	8,260	14,620	41,880	79,210	(145)
Peppers, sweet.....	2,720	4,700	8,470	-----	(145)
Potatoes <sup>6</sup> .....	660	1,430	-----	-----	(145)
Spinach.....	4,550	9,530	37,460	-----	(145)
Sweetpotatoes.....	1,715	2,530	5,290	-----	(145)
Tomatoes:					
Mature-green.....	580	1,070	6,230	-----	(145)
Ripe.....	1,020	1,260	5,640	-----	(145)

<sup>1</sup> Avocados at 50° F., 12,230; at 59°, 26,440. Unpublished data from J. Biale.

<sup>2</sup> Bananas at 68°, 8,800.

<sup>3</sup> Grapefruit at 70°, 4,180.

<sup>4</sup> Cranberries at 50°, 1,725.

<sup>5</sup> Onions at 50°, 1,870; at 70°, 3,630.

<sup>6</sup> Potatoes at 70°, 2,860.

provide added moisture to preserve freshness and also supply refrigeration. Moisture loss may also be reduced with certain products by the use of film box liners and bags (27, 44).

## Diseases

Diseases caused by bacteria and fungi and disorders resulting from abnormal functioning of fruits and vegetables are numerous and may cause serious losses in fresh produce after harvest (93-97, 109, 110, 113, 114, 138). Decay-producing organisms (fig. 14) are responsible for more losses during transit than physiological or functional disorders. Both decay and

physiological disorders, however, are directly influenced by temperature. In general, rots develop most rapidly at 70° to 85° F. Many of these decays are retarded significantly by a reduction of only 10 to 20 degrees in commodity temperature. At 32° most decay-producing organisms are inactive, although there are some that develop slowly even at this temperature.

Many diseases originate in the field. Control should be directed toward selection of resistant varieties and an adequate spraying and dusting program. Some diseases of field origin are superficial and do not change or increase during transit. Certain types of diseases, such as late blight rot in potatoes and tomatoes, and

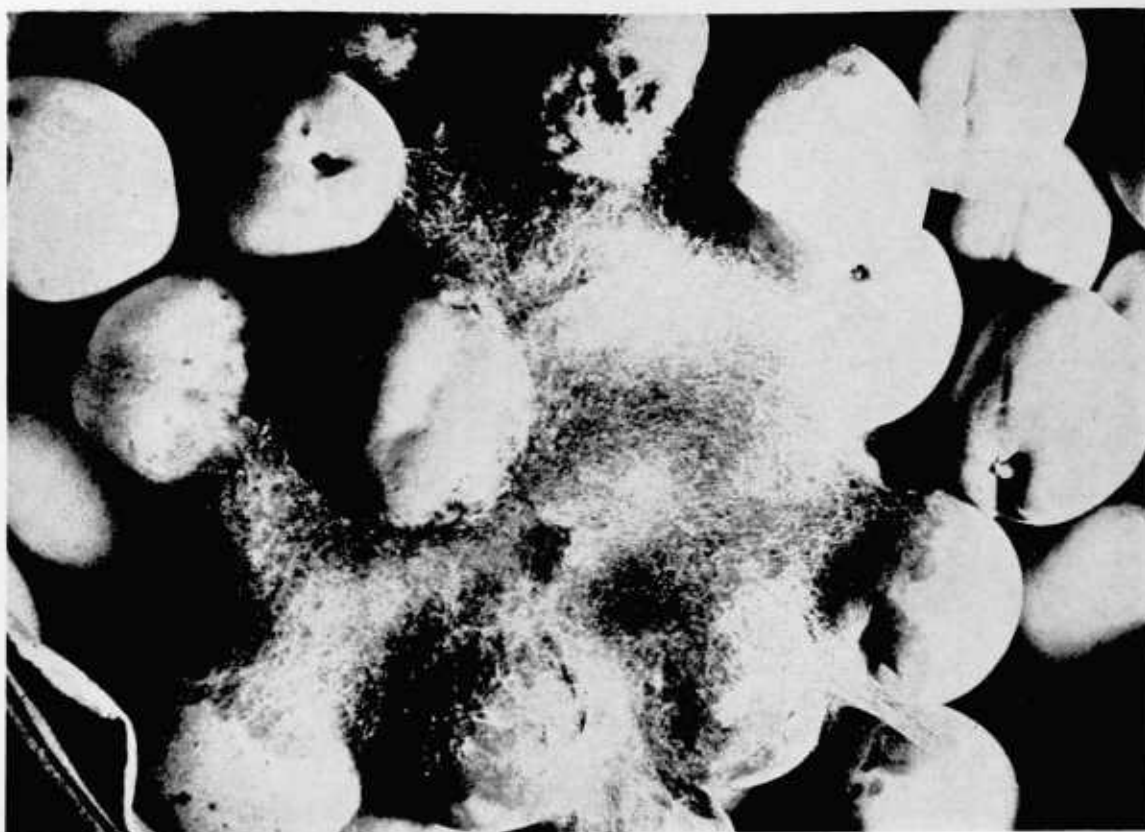


FIGURE 14.—Transit decay in peaches (Rhizopus rot).

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buckeye rot in tomatoes, are field infections, but the disease may not be evident at time of packing. Incipient infections of the diseases mentioned develop into active diseases in time, regardless of transit temperatures. Many of the decays important during the postharvest period cause little or no loss to the crop or commodity in the field. In practically all cases, however, the organism is present in the soil or on weakened or dead plant materials in the field. The majority of rots, therefore, occurring in transit and on the market are the result of infection by fungi and bacteria present on the fruits or vegetables when harvested. The amount of decay caused by these rots in transit is influenced by the inoculum present in the field; by weather before and during harvest; and by environment during marketing. Natural or mechanical breaks in the epidermis permit infection and possible decay.

Various chemical treatments have been developed for retarding decay in transit. These

include sulphur dioxide fumigation for grapes (120), diphenyl liners and wraps for citrus fruits (38), and various sprays and dips (19, 20). While these treatments are effective in varying degrees, they are only supplemental to adequate refrigeration.

### Mechanical Damage

Much deterioration is caused by mechanical damage which may occur at any time from harvest on. Careful handling is necessary at all stages in moving produce to market. Mechanical damage is evidenced as bruises, shatter, cuts, and abrasion. Several of the most damaging decay organisms can gain entrance into fruits and vegetables only through breaks in the skin, many of which are caused by rough handling. Proper containers, pads and other cushioning material, proper loading and bracing, and careful handling of cars in transit are all necessary to reduce mechanical damage.

### COMMODITY REQUIREMENTS

In this section there is a brief description of each of the commodities covered by the handbook. The descriptions include perishability,

transit requirements of temperature and humidity, principal market disorders, special packaging or loading requirements, and other

information pertinent to proper handling in transit. Desired transit temperatures and related data are given in tables 2 to 5.

### Fresh Fruits

#### Apples

Desired transit temperature, 32° to 40° F.

Most of the apple crop is held in cold storage and shipped to market during winter and spring. The rest of the crop moves directly to market during the harvest season (25). Apples shipped at harvest that are destined for storage should be cooled rapidly and shipped under refrigeration to hold ripening to a minimum. Apples of any variety harvested near the end of the season are more mature than those harvested earlier, so further ripening in transit before consumption may not be necessary. It is especially important, therefore, that this late fruit be shipped at low temperatures.

Under proper environmental conditions long-keeping varieties of apples may be stored for

several months, thereby furnishing a steady supply of fruit for the market through the winter and spring (3). Temperatures of 30° to 32° F. are required for most varieties during this long storage. Certain other varieties, which are injured by long exposure to temperatures below 40°, may be held satisfactorily for extended periods in 38° to 40° storage rooms if the amounts of oxygen and carbon dioxide are controlled therein. This is the so-called "controlled atmosphere" or CA storage (125). The storage life of apples is greatly affected by the rapidity with which their temperature is lowered to the optimum level.

Apples shipped from cold storage should have a protective service which provides for temperatures as nearly like cold-storage temperature as possible. Because apples from storage are at temperatures close to the freezing point of the fruit, little reserve heat is available, so shipments exposed to cold weather for several days can freeze quickly if not protected by heater service. Overheating in transit must

TABLE 2.—Desired transit temperatures for certain fresh fruits and vegetables

Fresh fruits		Fresh vegetables	
Commodity	Desired transit temperature	Commodity	Desired transit temperature
	° F.		° F.
Apples.....	32 to 40	Asparagus.....	34 to 38
Apricots.....	32 to 34	Beans (snap) <sup>1</sup> .....	45 to 50
Avocados:		Beets.....	32 to 40
Most varieties.....	45	Broccoli.....	32 to 36
West Indian varieties.....	55	Cabbage.....	32 to 40
Bananas (green).....	56 to 60	Carrots.....	32 to 38
Cherries (sweet).....	32 to 36	Cauliflower.....	32 to 40
Citrus:		Celery.....	32 to 36
Grapefruit.....	48 to 52	Corn (sweet).....	32 to 36
Lemons.....	50 to 55	Cucumbers.....	45 to 50
Limes.....	48 to 50	Endive and escarole.....	33 to 36
Oranges (Ariz., Calif., and Tex.).....	33 to 45	Lettuce.....	32 to 36
Oranges (Florida).....	40 to 45	Melons:	
Tangerines.....	32 to 38	Cantaloups.....	35 to 40
Cranberries.....	36 to 40	Honeydew.....	45 to 50
Dates.....	40 to 50	Onions (dry).....	32 to 40
Figs (fresh).....	32 to 36	Peas (green).....	32 to 36
Grapes (Vinifera).....	32 to 40	Peppers (sweet).....	45 to 50
Peaches and nectarines.....	32 to 45	Potatoes:	
Pears <sup>2</sup> .....	45 to 55	Early-crop.....	55 to 65
Pears <sup>3</sup> .....	32 to 36	Late-crop.....	40 to 50
Pineapples:		For chipping, early-crop.....	60 to 70
Mature-green.....	50 to 60	For chipping, late-crop.....	50 to 65
Ripe.....	40 to 50	Radishes.....	32 to 40
Plums (including fresh prunes) <sup>4</sup> .....	35 to 45	Spinach.....	32 to 40
Strawberries.....	32 to 35	Sweetpotatoes.....	55 to 60
		Tomatoes:	
		Mature-green.....	55 to 65
		Pink.....	45 to 50

<sup>1</sup> If watery soft rot is present in snap beans at time of loading, a transit temperature of 40° to 45° is desirable to retard this decay, even though some chilling injury may occur.

<sup>2</sup> Pears of all varieties shipped for immediate distribution and consumption.

<sup>3</sup> Pears for storage in producing area, at terminal market, or for transshipment.

<sup>4</sup> Class of service and desired transit temperature will depend largely on the maturity of fruit and whether or not the shipment is made in a fan car.

TABLE 3.—*Approximate freezing points of certain fresh fruits and vegetables<sup>1</sup>*

Fresh fruits		Fresh vegetables	
Commodity	Approximate freezing point	Commodity	Approximate freezing point
	° F.		° F.
Apples.....	28.0	Asparagus.....	30.5
Apricots.....	29.5	Beans (snap).....	30.0
Avocados.....	30.0	Beets (roots).....	29.5
Bananas.....	29.5	Broccoli.....	30.5
Cherries (sweet).....	27.0	Cabbage.....	30.5
Citrus:		Carrots (roots).....	29.0
Grapefruit.....	28.5	Cauliflower.....	30.0
Lemons.....	29.0	Celery.....	31.0
Limes.....	28.0	Corn (sweet).....	31.0
Oranges.....	28.0	Cucumbers.....	30.5
Tangerines.....	29.5	Endive and escarole.....	31.0
Cranberries.....	30.0	Lettuce.....	31.0
Dates.....	-4.0	Melons:	
Figs (fresh).....	27.0	Cantaloups.....	30.0
Grapes (Vinifera).....	27.0	Honeydew.....	30.0
Peaches and nectarines.....	29.5	Onions (dry).....	30.0
Pears.....	28.5	Peas (green).....	30.0
Pineapples.....	29.5	Peppers (sweet).....	30.5
Plums (including fresh prunes).....	28.5	Potatoes.....	30.0
Strawberries.....	30.0	Radishes.....	30.0
		Spinach.....	31.5
		Sweetpotatoes.....	29.0
		Tomatoes.....	30.5

<sup>1</sup> Although temperatures shown in the table represent actual freezing points, certain fruits and vegetables are susceptible to cold injuries at temperatures considerably higher than those above indicated. Further reference to such critical temperatures is shown elsewhere in this handbook for the particular commodities involved. More detailed information on the freezing points of fresh fruits and vegetables, on which the above table is based, may be found in two USDA publications (136, 145).

be avoided to prevent overripening which can cause a rapid deterioration in quality and flavor. During heating, car fans should be operated to prevent temperatures in the top layers from rising too high and to keep fruit in the bottom layers from freezing. Thermostatically controlled alcohol heaters are now used almost exclusively for shipments of apples under heater service from the Pacific Northwest, and heater thermostats should be set preferably at 32½° (104, 105, 147).

If apples are shipped without transit refrigeration, vents should be kept closed to prevent outside air at higher temperatures from entering the car and warming the fruit. Apple shipments moving out of Heater Territory to warmer areas in the south and southeast should be changed to refrigeration service at diversion points such as Laurel, Mont., or Kansas City, Mo. When danger of frost is past in the spring, ample refrigeration is required, as apples at that time are near the end of their storage life and every precaution must be taken to maintain their residual quality.

The quality of apples is greatly affected by bruising (fig. 9), which not only reduces salability but also increases susceptibility to infection by decay organisms (148). Mature apples,

especially those which have been stored for long periods, are more easily bruised and therefore require more careful handling and packing than those freshly harvested. Suitable containers and padding are necessary to minimize bruising in transit and marketing. The 1-bushel wooden apple box has been the standard container for apples in the Northwest for many years but various types of fiberboard boxes are now being extensively used. These include a number of tray packs and cell packs which afford greater protection from bruising during shipment. Solid loads may be used safely with apple shipments as apples are not usually pre-cooled in the car. It is desirable to leave a space between the containers and car walls to minimize the danger of freezing during winter shipments in cars without sidewall flues. Film box liners have been used with success to prolong the storage life of Golden Delicious apples by preventing moisture loss and shriveling (27).

Most of the diseases of apples affect the fruit while it is in storage (114). Decay in transit is controlled by transit temperatures of 32° to 40° F. This temperature not only retards the growth of the rot-producing fungi, but, by also retarding ripening, decreases the susceptibility

TABLE 4.—*Suggested temperatures to specify for shipments of certain fresh fruits and vegetables in mechanically refrigerated cars under Rule 710, Perishable Protective Tariff*

Fresh fruits		Fresh vegetables	
Commodity	Temperature	Commodity	Temperature
	° F.		° F.
Apples.....	33	Asparagus.....	35
Apricots.....	33	Beans (snap) <sup>1</sup> .....	46
Avocados:		Beets.....	33
Most varieties.....	46	Broccoli.....	33
West Indian varieties.....	56	Cabbage.....	33
Cherries (sweet).....	33	Carrots.....	33
Citrus:		Cauliflower.....	33
Grapefruit.....	50	Celery.....	33
Lemons.....	52	Corn (sweet).....	33
Limes, green.....	49	Cucumbers.....	46
Oranges (Ariz., Calif., and Texas) <sup>2</sup> .....	35	Endive and escarole.....	34
Oranges (Florida) <sup>2</sup> .....	42	Lettuce.....	34
Tangerines.....	33	Melons:	
Cranberries.....	37	Cantaloups.....	36
Dates.....	42	Honeydew.....	46
Figs (fresh).....	33	Onions (dry).....	33
Grapes (Vinifera).....	33	Peas (green).....	33
Peaches and nectarines <sup>3</sup> .....	36	Peppers (sweet).....	46
Pears <sup>4</sup> .....	47	Potatoes:	
Pears <sup>5</sup> .....	33	Early-crop.....	57
Pineapples:		Late-crop.....	42
Mature-green.....	52	Early-crop, for chipping.....	60
Ripe.....	42	Late-crop, for chipping.....	60
Plums (including fresh prunes) <sup>6</sup> .....	42	Radishes.....	33
Plums (including fresh prunes) <sup>7</sup> .....	36	Spinach.....	33
Strawberries.....	33	Sweetpotatoes.....	56
		Tomatoes:	
		Mature-green.....	56
		Pink.....	47

<sup>1</sup> If watery soft rot is present in snap beans at time of loading, a temperature around 42° is desirable to retard this decay, even though some chilling injury may occur.

<sup>2</sup> The desired temperature will depend on variety and shipping area.

<sup>3</sup> If slight ripening in transit is desired, a temperature of 45° will be suitable.

<sup>4</sup> Pears of all varieties shipped for immediate distribution and consumption.

<sup>5</sup> Pears for storage in producing area, at terminal market, or for transshipment.

<sup>6</sup> Plums of average maturity.

<sup>7</sup> Plums above average maturity.

of the fruit to decays such as blue mold, gray mold, and bull's-eye rots. Most disorders of apples, including not only rots such as blue mold but certain physiological diseases such as Jonathon spot and scald, are reduced by prompt cooling (to 30°–32°) of the fruit immediately after harvest and maintenance of temperatures close to this range until the fruit is consumed. Jonathon spot and scald may develop rapidly at warm temperatures after the fruit has been removed from cold storage. Bitter pit, another physiological disorder, has its inception in the orchard. Its further development is retarded at temperatures of 32° to 40°; in susceptible varieties of apples it could develop appreciably in 7 to 10 days at 50° to 60°.

Blue mold rot is the most important decay organism affecting apples. It is controlled by low temperatures (30°–32° F.). As this decay is primarily a wound parasite, it usually enters the fruit through skin breaks caused by bruising or other mechanical injury (148).

Hence, careful handling in harvesting, packing, storing, and shipping is of utmost importance to minimize physical damage to the fruit.

### Apricots

Desired transit temperature, 32° to 34° F.

Apricots are very perishable, and losses from injury and decay are considerable. For best results, apricots must be harvested and moved quickly. The fruit should not be left in the sun after picking as it has a tendency to self-heat. Brown rot, an orchard disease caused by a fungus, may develop in apricots during transit and in the market (113). It can be retarded by temperatures below 50° F. New infections are almost entirely prevented at such temperatures. A spotting known as scab or shot hole also occurs on apricots in California and the Pacific Northwest. However, it does not de-

TABLE 5.—*Recommended thermostat setting for LF (liquid fuel) heaters in shipments of certain fresh fruits and vegetables<sup>1</sup>*

Commodity	Thermostat setting
<i>° F.</i>	
<i>Fresh fruits</i>	
Apples.....	32½
Avocados <sup>2</sup> .....	45
Pears <sup>3</sup> .....	47½
Pears <sup>4</sup> .....	32½
Pineapples:	
Mature-green.....	52½
Ripe.....	42½
<i>Fresh vegetables</i>	
Celery.....	35
Peppers (sweet).....	45
Potatoes:	
Late-crop.....	40 to 45
Late-crop, for chipping.....	60
Tomatoes:	
Mature-green.....	50
Pink.....	47½

<sup>1</sup> If LF heaters are used in shipments of commodities not listed in this table, the heater thermostat should be set as near as possible to the transit temperature shown in table 4 for the commodity.

<sup>2</sup> Applies to winter shipments of avocados from California.

<sup>3</sup> Pears of all varieties shipped for immediate distribution and consumption.

<sup>4</sup> Pears for storage in producing area, at terminal market, or for transshipment.

velop or spread in transit or storage. Apricots moving by freight service should be room-precooled to 32°, but loading temperatures of 35° to 40° are adequate for express shipments. Shipments from both areas should be loaded in pre-iced cars. Standard Refrigeration Service is required in transit with 2 to 4 percent salt added to the ice depending on the weather. In California wrapped dry ice is frequently added with from 800 to 1,000 pounds placed in the brace at doorway and 100 pounds in each bunker with the water ice. The dry ice is not intended for refrigeration, but is used mainly to retard decay and preserve freshness through effects of the carbon dioxide added to the car air. California shipments move via express, whereas those from the Pacific Northwest are generally transported by freight. The use of fan cars is recommended for apricots.

### Avocados

Desired transit temperature, 45° to 55°F.

The avocado is an extremely tender fruit and requires very careful handling. The fruit bruises easily and is very susceptible to decay when the skin is broken. Dothiorella rot is the

most important rot of California avocados (110). The fungus (which occasionally induces stem-end rot) sometimes enters the fruit before harvesting. As the fruit softens, rot develops. This is about the time the fruit reaches the consumer. The marketing problem is further complicated by the fact that a method of detecting incipient infections has not been developed to eliminate infected fruits before shipping. The fruit is less susceptible early in the season. Cercospora spot or blotch is the most important disease of Florida avocados and is characterized by lesions and slightly sunken spots on the fruit. Scab and anthracnose are other common diseases affecting the avocado in Florida.

Most varieties should be transported at a temperature around 45°F., but the West Indian varieties which predominate in Florida should be transported near 55°. If avocados remain in transit for extended periods at relatively high temperatures, they will ripen rapidly and become soft. Avocados should be precooled to the desired transit temperature before shipment and loaded in *pre-iced* cars. Florida shipments need not be precooled if fruit temperature is not above 60° at loading. All varieties should be given moderate refrigeration service in transit, dependent on weather, as avocados will not ripen satisfactorily if they are held long at temperatures below 45°. Transit heater service is necessary during cold weather. Car vents should be kept closed. When LF heaters are used for California avocados, the heater thermostat should be set at 45°.

### Bananas (green)

Desired transit temperature, 56° to 60°F.

Most bananas shipped commercially do not ripen properly on the plant so they must be picked and shipped green (3). In this condition they can be handled without excessive bruising but are very susceptible to chilling injury at temperatures below 54°F. and ripen rapidly above 60°. Practically all rail shipments of bananas are made under the control of representatives (banana messengers) of the companies importing this fruit, who have developed from experimentation special rules for handling in transit. Because of this, recommended protective services for bananas are not included in this handbook. Detailed information for such handling should be obtained from the importer through whom the receiver obtains his bananas. Other instructions pertaining to the transportation of bananas will be found in Rules 105 and 110 of the Perishable Protective Tariff.

### Cherries (sweet)

Desired transit temperatures, 32° to 36°F.

Rhizopus rot, gray mold rot (*Botrytis*), green mold rot (*Alternaria*), and blue mold rot (*Penicillium*) are the most common diseases affecting sweet cherries (113). Some of these are particularly destructive during transit and marketing, especially in the presence of skin breaks and excessive moisture. Skin breaks can be greatly reduced by avoiding excessively tight packing and careless handling before and during loading. Rhizopus rot can be fairly well controlled in transit by temperatures of 40° to 45° F., but the other organisms can grow slowly at 32° and below. It is, therefore, important to place cherries in a cold room as soon after picking as possible. They should be pre-cooled overnight to about 32°, and subsequently loaded in a pre-iced car.

Maximum refrigeration service should be provided in transit, with 2 to 3 percent salt added at pre-icing and all re-icings (146). Additional retardation of decay and maintenance of green stems can be accomplished by the carbon dioxide released from 800 to 1,000 pounds of wrapped dry ice placed in the doorway brace. An additional 100 pounds of dry ice can be broken up in each bunker with the water ice. Recent development of polyethylene liners for lug boxes of Northwestern cherries has eliminated the need for dry ice in these shipments (28, 29). Because the polyethylene liners extend the marketable life of the cherries, it is now possible to ship safely by freight instead of express, and this is steadily increasing in the Pacific Northwest. California shipments move mostly by express, using dry ice instead of the film liners. To maintain uniform temperatures, fan cars are recommended.

### Citrus (grapefruit)

Desired transit temperature, 48° to 52°F.

Some of the more important decays and physiological disorders affecting grapefruit are the same as those involving oranges: blue mold, green mold, stem-end rot, and pitting (37, 110, 112, 123, 139). Blue mold and, to a greater extent, green mold rots are a problem each year in all citrus producing areas in the United States. Stem-end rot causes important losses each year in shipments of citrus fruits from Florida and Texas during rainy years but is of minor importance in arid States such as Arizona and California. The first consideration for the control of blue mold and green mold rots is careful handling throughout the harvesting, packing, and marketing periods, to minimize peel breaks through which infections oc-

cur. The growth of decay fungi can be retarded by treating the fruit with certain approved chemical dips, chemical-impregnated wraps or liners, and fumigants (38). These treatments are used either singly or in combination and are complementary to prompt and effective cooling to 50°F.

Pitting is a physiological disorder common to grapefruit when held in temperatures near 40°F. Early-season fruit is especially susceptible, often showing the typical peel pitting within 15 days. Late-season fruit may not show the injury until after a storage period of 4 to 6 weeks. Grapefruit may not be adversely affected by short exposure to temperatures near 40°. However, peel pitting can develop in export shipments and also in distant domestic shipments if the fruit is held by the receiver for several days at undesirable temperatures. A transit temperature of 48° to 52° is recommended for grapefruit because of the impossibility of determining in advance its susceptibility to pitting. The increased protection against pitting provided by this temperature range compensates for any possible slight increase in decays.

Protective services in transit are somewhat the same as those required for oranges, such as ventilation only, ventilation in conjunction with refrigeration service, or cooling with ice ranging from modified icing service to maximum refrigeration (144). Precooling of grapefruit before shipment will be governed by fruit temperature, fruit condition, and the weather. When necessary, precooling to 50°F. is recommended. As with oranges, some grapefruit is "degreened" to produce a normal color by the use of ethylene gas (140). However, more rapid development of stem-end rot will occur in gassed fruit, if the coloring-room operation is improper or the temperature therein is not kept between 80° and 85°.

As with oranges, when treatments are applied which raise the temperature of the fruit, consideration must be given to the removal of this excess heat by precooling or additional transit refrigeration. The use of fiberboard boxes poses the same cooling problem as with oranges and open loads (fig. 15) are necessary (41, 142).

### Citrus (lemons)

Desired transit temperature, 50° to 55°F.

Lemons are stored and transported at higher temperatures than other citrus fruits. Lemons sometimes become pitted if held for prolonged periods at low storage temperatures but pitting is rare at temperatures above 55°F. Brown rot



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FIGURE 15.—One loading method used to provide vertical zigzag air channels through a carton load of citrus (Freight Tariff 823-c, loading rule 210; so-called spaced bonded-block load).

caused by a soil-borne fungus is found on lemons in groves, in packing houses, and in storages (110). Due to the acidity of the juice the fungus is usually confined to the rind, the central cylinder, and the tissues between the segments of flesh. Certain chemicals are sometimes added to the wash water to prevent infection in the packing house. However, the treatment most commonly used at present to control brown rot is to submerge the fruit for 2 minutes in water heated to 115°, or for 1 minute in 120° water. This disease, as well as blue mold and green mold rots, is greatly retarded at a temperature of 50°. Chemical treatments immediately after harvesting also afford an effective control of these diseases.

Cottony rot, another important disease affecting lemons, is a rapidly spreading contact decay that may attack both green and mature fruit, and cause heavy losses in the packing-house or in storage. At the relatively high temperatures deemed suitable for lemon shipments the decay-producing fungus may cause substantial damage. However, temperatures of 50° to 55° in transit afford the best control of most disorders of lemons. Careful handling, packinghouse sanitation, and washing the fruit in hot water (as for brown rot) are recommended for preventing cottony rot. These same control measures should also be used for gray

mold rot, which is more common on lemons than on other citrus fruits. This rot is rarely found in the orchard, but is very common in transit, in storage, or on the market.

For winter shipments of lemons Standard Ventilation only is generally used, but some refrigeration is recommended for weaker fruit such as "tree ripens" and "B-Silver" lemons. Various modified refrigeration services may be used for summer shipments or for cars moving to points in the South (42). Pre-iced cars, with bunker ice replenished after loading, are recommended. The need for re-icing in transit will be governed by weather and by distance to market. If a fan car is used for ventilated shipments it is recommended that the fans be kept in operation. This, of course, also applies to cars moving under refrigeration. Practically all lemons are now packed in fiberboard cartons. Transit cooling is not a problem with lemons as they are usually near the desired transit temperature when loaded.

#### Citrus (limes)

Desired transit temperature, 48° to 50°F.

Limes are subject to some of the same diseases that attack oranges and grapefruit: pitting, blue mold, green mold, and stem-end rot (110). They are subject to pitting at tem-

peratures below 45° F. and develop stem-end rot at temperatures above 50°. The most important transit disease of limes is stylar-end breakdown occurring in fruit of advanced maturity. Occasionally this disease appears at the stem end as well as at the stylar end. During early stages no organism has been found associated with the disease, therefore it is considered physiological in nature. The only control measure that can be recommended is to pick the fruit before it becomes too mature. Rind breakdown such as conspicuous spotting or collapse of the rind occurs in limes during transit and storage. The name "scald" has often been used for this trouble. Control measures consist of careful handling, prompt shipment, and storage at temperatures between 48° and 50°. Limes should be room-precooled to 52°-55° during warm weather. Modified icing service in transit will suffice.

### Citrus (Oranges)

Desired transit temperature: Arizona, California, Texas, 33° to 45°F.; Florida, 40° to 45°.

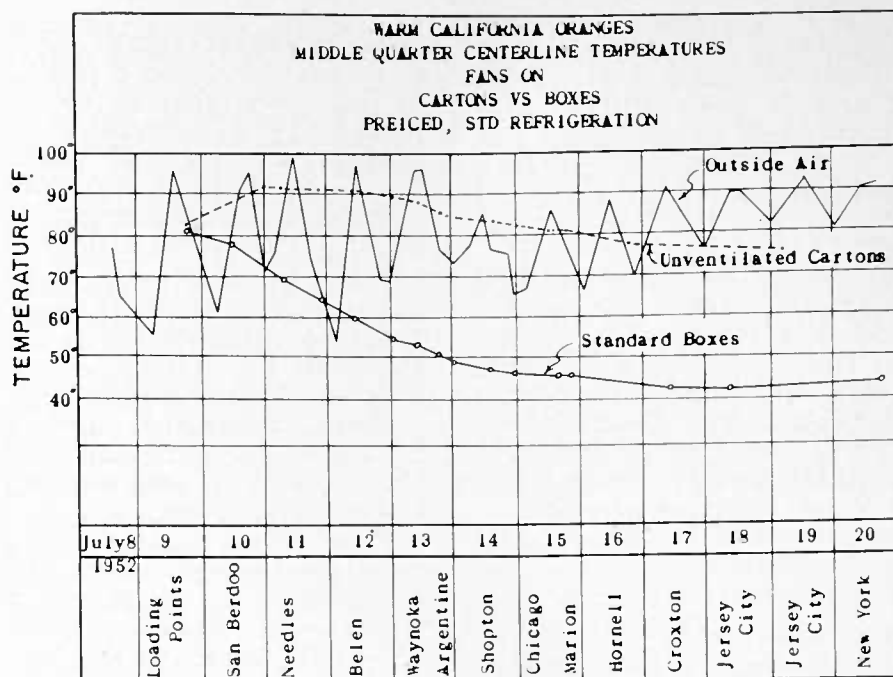
The important decays and physiological disorders affecting oranges are blue mold, green mold, and stem-end rot (110, 112). Blue mold and green mold rots in particular are prevalent in all citrus-producing areas. Stem-end rot is responsible for serious losses in Florida oranges each year and during rainy seasons in Texas, but is of minor importance in Arizona and California. Careful handling throughout the harvesting, packing, and marketing periods is of primary importance to minimize peel breaks, through which infections such as blue and green mold rots enter. Certain approved chemical dips, chemical-impregnated wraps or liners, and fumigants may be used to retard the growth of these decay fungi (39, 139). These treatments are complementary to prompt and effective precooling to 50°F. at which temperature oranges will generally remain free of decay for 5 to 6 days. Additional cooling in transit will lower the fruit temperature to 45° or under. Oranges are more subject to decay than grapefruit but are less susceptible to pitting at temperatures below 40° than grapefruit. Early and midseason varieties are usually more susceptible to pitting than late-ripening varieties, the pineapple variety from Florida being especially susceptible even during comparatively short periods in transit. Pitting is generally more severe at 36° to 40° than at either higher or lower temperatures.

Oranges, when stored, are usually held at 32° to 34°. This temperature affords increased protection against decay fungi. Overrefrigeration is therefore not a factor in the transportation

of oranges. The exact amount of refrigeration to be used for obtaining desirable temperatures in transit will depend upon fruit temperature at time of loading, variety, quality, weather, distance to market, and whether or not the shipment was precooled. The shipper may select various classes of protective service such as ventilation only (comprising both Combination Ventilation and Standard Ventilation) or cooling with ice, ranging from modified icing service to Standard Refrigeration Service (73, 144). Ventilation is generally used with winter shipments but it may be needed during cool weather in other seasons, even in conjunction with a refrigeration service. A substantial number of orange shipments are precooled depending on the type of container used, weather, and condition of the fruit.

Early in the season some orange varieties are legally salable before developing normal yellow color, but frequently such oranges are treated with ethylene gas to degreen them (140). However, this gassing treatment sometimes accelerates development of stem-end rot, if proper coloring-room procedure is not followed. Because of considerable variation in the color of oranges from time to time, some are colored with a harmless dye to improve their appearance. This process is referred to as "color added," and the fruit is so stamped. The use of heated solution in this process sometimes produces "aging," which causes browning, wilting, and shriveling around the stem button or elsewhere on the upper part of the fruit. Oranges from some areas are given a waxing treatment which is believed to help minimize weight losses and retain a bright appearance for a longer time.

All treatments which raise the temperatures of the fruit increase the refrigeration requirements. Consideration must be given to the removal of this excess heat through precooling or increased transit refrigeration. The rapid increase in the use of fiberboard cartons for all citrus fruits has resulted in slower cooling rates because of the difficulty in moving air through the packages and the tighter loads as shown in figure 16 (41, 43, 142). As much space should be provided as possible in the load by means of channels (fig. 15) or the chimney method (fig. 27, page 56) and more time should be used for precooling in car. Bulk hydrocooling of oranges is being used in a number of Florida packinghouses. Fungicides are added to the hydrocooling water to reduce the development of decay. The fruit is then packed in regular wirebound or fiberboard containers, or in polyethylene bags placed in master containers.



AMS Neg. 8152-60(10)

FIGURE 16.—Temperature curves showing lack of cooling in unventilated cartons of warm oranges in center of load as compared with standard boxes.

### Citrus (tangerines)

Desired transit temperature, 32° to 38°F.

This fruit is highly perishable and not adapted to long storage (40). Tangerines become more tender as ripening progresses. They are then especially susceptible to green mold rot (110). Temperatures of 38°F. and below are quite effective in retarding this decay. The usual packinghouse chemical treatment to check green mold in other citrus fruits should also be given tangerines. This treatment is best made soon after the fruit reaches the packinghouse. Tangerines should be thoroughly pre-cooled before shipment, after which moderate refrigeration will suffice, depending on weather and distance to market (143). The use of fan cars is recommended.

### Cranberries

Desired transit temperature, 36° to 40°F.

The keeping quality of cranberries is determined by growing conditions, maturity, variety, and storage procedures. They can be successfully stored from 3 to 4 months at temperatures around 36°F. and fairly high relative humidity (47, 48). However, such temperatures are not always available in growers' warehouses, where most of the storage life of the fruit is spent. Fruit stored for 4 months at 36° should be retailed as quickly as possible thereafter, since such fruit is very susceptible

to bruising and physiological breakdown (134). Even at low temperatures decay will develop. Moreover, at temperatures close to 32° cranberries are subject to physiological breakdown, resulting in the flesh losing its normal white color and crisp texture. The flesh then becomes red, tough, and rubbery, and the skin loses its characteristic high luster. At temperatures above 40° (especially above 50°) decay development greatly increases.

The rots occurring in cranberries are numerous and not easily distinguished from each other, even when examined by a specialist (109). Bruising of the fruit during picking, sorting, and packing operations should be avoided, especially if the fruit is wet. However, these precautions alone will not necessarily control decays and incipient fungus infections already existing in the fruit before harvest (128). Fungus rots can be controlled to a considerable extent by chemical spraying in the field, also by precooling freshly harvested, pre-packaged cranberries in the car or cold storage rooms especially during warm weather. Cold storage rooms for precooling purposes are being given some consideration by certain cranberry growers.

Solid loads of warm (nonprecooled), pre-packaged cranberries packed in master cartons cool slowly in transit, especially in the middle layer of the load. Tests have indicated that precooling freshly harvested cranberries re-

duces decay in transit (49, 59, 63). Transit temperatures of 36° to 40° F. are desirable for cranberries. To obtain such temperatures, recommended classes of protective service are given in table 7. If the weather is cool during the early portion of the trip ventilation service (no ice) may be used at the beginning, followed by refrigeration later on, if outside temperatures near destination are high. Or protective service ranging from modified refrigeration to Standard Refrigeration Service and 3 percent salt may be necessary. The governing factors are the temperature of the fruit at time of loading and the weather. If temperatures of the berries are *above* 60° when loaded, the shipment should be loaded in a *pre-iced* car, and then precooled in the car before departure.

### Dates

Desired transit temperature, 40° to 50°F.

Although temperatures lower than 40° F. are beneficial, they are not recommended because of increased service cost. Only room-precooled fruit is shipped in the summer. Although some precooling is also done during cooler weather, the lack of time results in much fruit being loaded fairly warm (122). During the summer, modified icing service is sufficient for dates. The use of maximum refrigeration is not warranted and is wasteful because of the solid loads used and the fiberboard placed over the car floor racks to protect the cartons. These practices obstruct air circulation and result in retarded heat removal from the load. During fall, winter, and spring, ventilation service only (no ice) is sufficient for date shipments. No heater service is ever required.

### Figs (fresh)

Desired transit temperature, 32° to 36° F.

Figs are extremely fragile and very susceptible to decay organisms. *Alternaria* spot, *Rhizopus* rot, and gray mold rot are the principal decays affecting fresh figs in transit and on the market (110). Figs should be promptly room-precooled or precooled in the car after harvest to temperatures of 33° to 36° F. If subsequently kept at temperatures not higher than 40°, they will not be seriously affected with decay in transit, or during the usual marketing period. Figs, due to their delicate nature, cannot be expected to keep satisfactorily for more than about 10 days. Expedited transit movement is desirable. Transcontinental shipments move in express cars, which should be pre-iced before loading. Standard Refrigeration Service with 3 percent salt added to the ice is necessary in transit. To further retard decay and excessive ripening of the figs

during transit carbon dioxide gas may be used as a supplement. In a good, tight car helpful concentrations may be obtained with 750 to 1,000 pounds of wrapped dry ice placed in the doorway area brace of shipments. An additional 100 pounds of dry ice may be broken up and placed in each car bunker with the water ice for rapid buildup. Only fan-equipped cars should be used.

### Grapes (Vinifera)

Desired transit temperature, 32° to 40° F.

California *Vinifera* table grapes must be cooled rapidly to preserve their quality (3, 120). They are shipped either immediately after harvest or after varying periods of storage. In either case, the fruit should be placed under refrigeration within a few hours after harvest. Undue delays at the high temperatures usually prevailing at harvest time will favor stem drying, berry shrivel due to moisture loss, shatter, and infection by decay organisms.

Precooling is accomplished for both shipping and storing grapes by the use of room precooling, forced-air cooling (32-34), cooling tunnels, and car precooling (80) (the latter when grapes move directly to market after harvest or are transported some distance to storage). Grapes are not adapted to vacuum cooling. They should be precooled to 40° F. or lower for immediate shipment and as close as possible to the desired holding temperature of 31° for storage. Temperatures below 40° should be maintained in transit. Car precooling is usually done by means of the built-in car fans, portable precooling fans, or a combination of both. The class of protective service required in transit will depend on the extent of precooling before shipment, as well as the prevailing weather and season (103). Mechanically refrigerated cars may be used to ship precooled or storage grapes but some are not designed for rapid precooling of warm loads.

The standard grape display lug is the commonly used container for grapes. Railroad tariffs require that these containers be loaded crosswise of the car. Some method for providing vertical air channels in the load should be used, particularly when the lading is precooled in the car. To accomplish this, the gate load, Hoak load, block load, or other similar load patterns may be used. Tight loading lengthwise of the car is essential to prevent any container movement which may result in shattering of the grapes in transit (82). Slack in the load can be eliminated by the proper use of a mechanical "car-squeeze" and an adequate center gate, as described in the applicable Freight

Container Tariff, to retain load tightness during transit.

The decays that sometimes develop during transit include those caused by *Botrytis*, *Cladosporium*, and *Alternaria* (109). The spread of *Botrytis* (gray mold) and *Cladosporium* is controlled quite effectively in both storage and transit by fumigation with sulfur dioxide gas, but fumigation does not kill infections that have occurred before harvest. Care must be taken to prevent excessive concentrations of SO<sub>2</sub> in the car during fumigation, or injury to the fruit will result (135). A supplemental fan in the brace will provide uniform distribution of the gas. In mechanically refrigerated cars, it may be necessary to open the doors after fumigation to aerate the car.

**FUMIGATION WITH SO<sub>2</sub> GAS MUST BE DONE WITH CAUTION TO AVOID INJURY TO WORKERS, FRUIT, AND EQUIPMENT. EVEN A CONCENTRATION OF 0.25 PERCENT CAN CAUSE RESPIRATORY SPASMS AND DEATH FROM ASPHYXIATION IF THE VICTIM CANNOT ESCAPE FROM THE FUMES. CONCENTRATIONS AS LOW AS 0.04 PERCENT ARE IRRITATING AND CAN INJURE THE MUCOUS MEMBRANES. A GAS MASK WITH CANISTER FOR ACID GASES, OR GOGGLES, SHOULD BE WORN EVEN WHEN WORKING IN WEAK CONCENTRATIONS.**

### **Peaches (and nectarines)**

Desired transit temperature, 32° to 45° F.

Peaches, when eating-ripe, are too soft to be shipped. They must, therefore, be harvested at a stage of maturity in which they are firm enough to be handled without excessive bruising (35). To maintain sufficient firmness during the movement to market, the fruit must be held at temperatures low enough to retard ripening until it reaches the retailer. Of equal importance is control of the two major decays affecting peaches: brown rot and *Rhizopus* rot (fig. 14) (113). Their development during extended transit periods (7 to 8 days) can be very rapid unless the fruit is held at 45° F. or lower. However, peaches held at 40° for 2 weeks or more may be affected by internal breakdown, which does not occur as rapidly at temperatures above or below this point. Holding temperature should be reached quickly after harvest by room precooling, precooling in cars, or hydrocooling.

In the eastern peach-growing area, hydrocooling (fig. 24, page 53) has become the most common method of precooling (106, 107, 129). In Colorado, precooling is done in the car by means of car fans or portable mechanical re-

frigerating units. Room precooling is the usual practice in California and the Northwest, although car precooling and hydrocooling are used to some extent. In hydrocooling, fruit temperatures should be reduced to 45° F. or lower and constantly checked to determine the performance of the hydrocooler. The water temperature should be in the range of 32° to 34° at all times for effective cooling. As the cooling rate will vary considerably with size of the peaches, the speed of the hydrocooler should be adjusted to provide the desired cooling when the average size of peaches being cooled changes. After removal from the hydrocooler the fruit should be loaded promptly into pre-cooled cars to prevent loss of refrigeration.

Warm peaches may be shipped immediately after loading in mechanical cars. The load will cool in transit within 18 to 24 hours. While this is a longer period than normally required for holding and *precooling* a load in an *iced* car at shipping point, it does eliminate the delay and extra cost that usually go with car precooling. Because of the slower cooling rate the peaches may ripen somewhat during this period. Fruit so shipped should be firm when loaded, to prevent excessive softening during transit with consequent increased bruising.

Peaches that are harvested before reaching proper maturity will not ripen with good dessert quality. Considerable interest has been shown by the industry in improved harvest maturity for raising market quality (21). Rapid precooling and transit temperatures below 40° are essential for fruit of advanced maturity. Bruising is also a serious problem, especially in bulging or overpacked containers, and better packaging than the conventional containers now used is desirable. Single and double layer tray-pack boxes of wood or fiberboard are being used, mostly in the west. Moisture-resistant cartons suitable for hydrocooling with jumble-packed fruit are becoming available. Many studies are now being made to develop containers that will afford better protection to the more mature fruit and still permit rapid and adequate cooling.

The standard tub peach baskets have received excessive damage when loaded in the usual upright manner in refrigerator cars. Extensive tests have shown that the alternately inverted crosswise offset load (fig. 17) greatly reduces basket breakage and also lowers refrigeration costs per package because of the larger load (127). Southeastern railroads have offered incentive rates on carlot shipments of peaches loaded in this manner, provided they are properly hydrocooled and a heavier load is used by adding another complete layer to the normal load.



FIGURE 17.—Alternately inverted load of  $\frac{3}{4}$ -bushel baskets in refrigerator car.

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Two serious transit decays of peaches are brown rot and *Rhizopus* rot (130). The fungus that causes brown rot occurs in the orchard and is favored by warm, wet weather. It is most prevalent in the Southeastern production area. Adequate spraying schedules plus proper packinghouse sanitation are the most effective controls. At least one chemical, sodium orthophenylphenate, applied after harvest, has been found to be effective in reducing brown rot infections (74). Tolerances have recently been established for this chemical by the Food and Drug Administration. Although brown rot can develop slowly at temperatures as low as 32° F., satisfactory control during normal transit periods is possible at the recommended temperatures of 32° to 45°. However, following the transit period and removal of the fruit to normal temperatures during retail handling, brown rot can develop rapidly, even though none was discernible at time of loading. Thus, it is important to reduce infections in the orchard with effective preharvest sprays. The *Rhizopus* rot organism usually attacks the fruit

after harvest, but its growth is held in check by transit temperatures of 45° and lower. Sodium orthophenylphenate is also effective for reducing *Rhizopus* infections. A buildup of spores of decay organisms in the hydrocooling water can be avoided by the addition of 100 to 200 parts per million of chlorine. However, this concentration will not eliminate any brown rot or *Rhizopus* rot infection already existing on the fruit.

Nectarines are handled the same as California peaches.

### Pears

The transit protective service for pears is determined largely on the disposition to be made of the fruit upon arrival at destination. It may go into immediate distribution and consumption, into cold storage in the East, or be transshipped for overseas sale (3).

(1) Desired transit temperature, pears of all varieties shipped for immediate distribution and consumption: 45° to 55°F.

Pears in this category should be partially ripened in transit so that it will not be necessary to hold them for extended periods for ripening after reaching market. Facilities available at destination often do not provide the proper environment for ripening, and result in poor quality fruit. Delay in ripening may cause an excessive accumulation of fruit in wholesale and retail channels which adversely affects prices. Depending on maturity at harvest, pears from the earlier districts usually require from 7 to 12 days to reach the eating-ripe stage when held at ideal ripening temperatures. Therefore, moderate transit temperatures should be provided to initiate this ripening process during a 6- to 8-day transit period (118, 119).

For early varieties shipped immediately after harvest (Bartlett, Bosc, Comice), modified icing services as indicated in the tables should be used to provide temperatures in the range of 45° to 55°F. for the first 5 to 6 days in transit. These icing schedules are based on a transit period of 7 to 10 days. With faster train schedules now in effect which provide delivery on the seventh morning in New York City, it appears that some further modification of protective services could be safely used. If a non-fan car is used, moderate precooling at origin should be done to avoid excessive ripening in the top layers during transit. For shorter transit periods (less than 6 days) the fruit may be treated with ethylene gas before or during shipment to hasten ripening (116).

Midseason and late pears are usually harvested at a more advanced stage of maturity, so less ripening in transit is needed. They are generally room or car precooled and shipped under a modified refrigeration service as indicated in the tables.

All varieties shipped from cold storage during fall or winter in fan cars may have ripening initiated in transit if desired, by the proper use of LF heaters with thermostats set at 47½°. Because of the low temperatures usually prevailing during transit in late fall and winter, no significant warming of the cold fruit can be expected from any natural source, so artificial heat must be applied. Tests have been made with winter shipments of pears from the Northwest in which heaters were installed at Chicago (90, 102). Fruit temperatures were raised to 50°-60° by the time of arrival in New York. Pears in these cars were then ripe enough for distribution 18 to 36 hours sooner than those in a companion car which was not heated. Other tests (91) indicated the feasibility of ripening pears by heating in fan cars after arrival at market (car fans operated by portable motors) (69) thus eliminating the

extra handling required to move the fruit through ripening rooms.

(2) Desired transit temperature, pears for storage in producing area or at terminal market, or for transshipment: 32° to 36°F.

For maximum storage life, pears must be quickly cooled to 31° to 32°F. and held continuously at that temperature, whether they are stored in the production area or at the terminal market. Consequently, temperatures near the optimum storage temperature should be maintained in transit. Fruit shipped immediately after harvest should be thoroughly precooled, either by room precooling or in the car, and shipped under maximum refrigeration in warm weather and some modified icing in cooler fall months. During severe cold weather, freezing damage in transit must be prevented by heater service with car vents kept closed to destination. Car fans should be operated in transit to prevent overheating (hence ripening) in the top layers of the load. The thermostat on LF heaters should be set at 32½°.

Practically all pears stored in the Pacific Northwest and some in California are now packed and stored in film-lined containers which increase their storage life and lengthen shelf life several days after ripening (27). To prevent possible fruit injury from excessive atmosphere changes during transit and retail handling, it is recommended that the film liner be slit at shipping point after removal from storage.

The most common transit decays of pears are blue mold and gray mold rots, bulls'-eye rot, and *Alternaria* rot (114). All of these decays develop slowly in storage but can increase if the fruit is exposed to higher temperatures in transit. However, development of these decays is retarded by the low transit temperatures previously recommended. Chemical treatments before storage and proper packinghouse sanitation will minimize sources of infection.

### Pineapples

Desired transit temperatures: Mature-green, 50° to 60°F.; Ripe, 40° to 50°.

Practically all pineapples moving by rail have been imported from Cuba. They were loaded in rail cars on the island and transported by car ferry to West Palm Beach or other Florida ports. Here they were reloaded into refrigerator cars for movement to points in the United States. In general, the class of protective service used is that which the buyer specifies to produce the desired break in color or stage of ripeness required upon arrival at the market. Pineapples are sensitive to temperatures below 40°F., especially mature green fruit, which

may retain its acid flavor and fail to color properly if exposed to such low temperatures. Therefore, temperatures of 50° and higher are needed for mature green fruit, depending on the ripening desired in transit. Ventilation service in warm weather and LF heaters during winter months are usually employed. To maintain the color break in ripe pineapples, temperatures of 40° to 50° in transit are desired. This will require the use of a modified refrigeration service in warm weather and LF heaters in cold weather, with heater thermostats set at 42½° for ripe and 52½° for mature green pineapples, and car vents kept closed.

Black rot, sometimes called soft rot, water blister, or water rot, is one of the most serious diseases affecting pineapples both in the field and in transit (110). The causal fungus enters the fruit through skin breaks caused by insect punctures or injuries received during harvesting, packing, and marketing processes. It develops more rapidly in ripe than in green fruit. Careful handling and packing is necessary to minimize infection. Black rot develops very rapidly at temperatures between 70° and 90°F. but becomes relatively inactive below 50° and will not develop in fruit below 45°.

#### Plums (including fresh prunes)

Desired transit temperature, 35° to 45°F.

Because of their perishability, plums and prunes (fresh) should be handled carefully at all stages of marketing, from the orchard to the consumer. They are not stored extensively, nor are they adapted to long cold storage. Moreover, fresh prunes coming out of storage at shipping point cannot safely be stored again after arrival at eastern markets. Thus the fruit should be put into trade channels as soon as possible after arrival at market. Plums are susceptible to the same rots as other stone fruits, the most important being *Rhizopus* rot, brown rot, gray mold rot, and blue mold rot (113). The controls usually found effective are adequate spray operations in the orchard, proper precooling of the fruit after picking, prevention of skin breaks and bruising during handling, and the avoidance of excessively tight packs (17).

The fruit should be either room precooled or precooled in the car to the recommended temperatures promptly after packing. The addition of salt to the bunker ice during car precooling is desirable. Transit temperatures of the fruit should be kept between 35° and 45°F. If the fruit is precooled soon after it is picked, a temperature of 45° or lower will fairly well retard the progress and development of the four principal decays. As indicated in table 7,

the extent of precooling at origin and also the class of protective service necessary in transit depends largely on the maturity of the fruit at loading and whether the shipment is being made in a fan car or in a car without fans. Fan cars should be given preference. All shipments should be loaded in pre-iced cars. The alternately inverted crosswise offset loading method (fig. 17) may be used for fruit packed in baskets, if the fruit is adequately precooled before loading and shipped in fan cars (127). It has been found that such a load pattern reduces basket damage and fruit bruising in transit. For nonprecooled fruit in nonfan cars it is believed the end-to-end offset method of loading provides some additional air space around the baskets and helps increase the cooling rate. With either method of loading, the baskets should not be overpacked or have a pronounced bulge in their lids.

#### Strawberries

Desired transit temperature, 32° to 35°F.

Strawberries are among the most perishable fruits shipped commercially by rail and, as such, require expedited handling in all phases of distribution. Hence all rail movement is by express. Because both ripening and development of decay after harvest are very rapid, and because of a high degree of susceptibility to bruising, the fruit must be handled with great care. Low temperatures will control both ripening and decay. Proper precooling is essential to remove field heat from the berries at the earliest possible time after picking. Precooling may be done in cooling rooms or in the car.

In room precooling the berries should be held for 8 to 12 hours or overnight at an air temperature as close to 32° F. as possible. Air-circulating fans should be used and the containers stacked to provide adequate air movement around the stacks. The precooled berries should be loaded in pre-iced cars and protected during loading by a door shield or tunnel to prevent warming up and wetting from condensation.

When cooling in the car, portable precooling fans in conjunction with the car fans should be used to obtain the maximum cooling rate (fig. 26, page 55). With berries packed in baskets in wire-bound crates, at least 4 hours of car precooling should be performed to reduce temperatures of berries at the doorway to near 40°. Fiberboard trays, unless loaded so as to provide air channels equivalent in area to those in a regular crate load, may require more time for precooling in cars. Bunkers should be carefully re-iced just before precooling starts and at least 400 pounds of salt should be worked

into the ice. The car should again be re-iced before moving in transit.

Only fan cars should be used for the movement of strawberries. They should be pre-iced at least 6 to 12 hours before loading. Tests have shown that after express fan cars start moving in transit, cooling by car fans continues at about half the rate occurring during precooling with car fans and portable precooling fans combined. This factor should be considered when determining whether to release a car after it has been given only the minimum precooling time.

Strawberries shipped from the Louisiana area are precooled in the car and move during relatively cool spring months (100). If precooling has been thorough, salt in transit may not be required. However, if the weather is hot en route or precooling was not thorough, 2 to 3 percent salt should be added at replenishing after precooling and at the first re-icing in transit. While no similar tests have been conducted in the strawberry areas of Arkansas, Tennessee, and Kentucky, it is believed that the above recommendations for Louisiana strawberries will also apply to these other areas. In California, where room-precooled berries are shipped over the greater part of the year, the transit protective service should be commensurate with the season. Standard Refrigeration Service is used throughout the year, but the amount of salt added varies with the weather (117).

Wrapped dry ice is commonly used to slow ripening and reduce decay in transit; from 800 to 1,200 pounds are required to produce the necessary concentration of carbon dioxide in the car. Carbon dioxide concentrations of 10 percent or above for 24 hours or more are quite effective in reducing the growth of decay organisms and in retarding ripening and softening of the berries. The dry ice should be placed in a crib or on a shelf built into the center brace in such a way that there is at least 6 inches between the closest dry ice and the berries. The additional refrigeration furnished by these amounts of dry ice should be considered in selecting the amount of salt to be added to the water ice in transit, or freezing damage may result. If 3 percent salt is indicated without dry ice, 2 or even 1 percent may be ample when the above amounts of dry ice are used.

The standard wirebound strawberry crates, loaded lengthwise with 2- to 4-inch vertical channels between rows, provide a very satisfactory pattern for rapid cooling. The fiberboard tray pack, when loaded with similar channels, also cools well. As California berries packed in these trays are room precooled, air channels in the load are of less importance.

All containers should be carefully handled because the berries are easily bruised.

The principal transit decays of strawberries are gray mold and *Rhizopus* rot (109). It is very important to ship only sound fruit, free from all defects, since these decay fungi, by nesting, can spread throughout the container. In transit, *Rhizopus* rot is more likely to be found in berries exposed to temperatures above 50° F., whereas gray mold predominates at temperatures below 50°. Although the latter decay may develop slowly at lower temperatures, maintaining the load at 32° to 35° should safely protect the fruit from decay during transit.

## Fresh Vegetables

### Asparagus

Desired transit temperature, 34° to 38°F.

Asparagus is one of the most perishable commodities shipped commercially. It requires special care at all stages of distribution. Once harvested, asparagus quickly loses its quality while undergoing marked changes in structure and chemical composition (66, 67). It has a very high rate of respiration (table 1), even at low temperatures. At temperatures above 40° F. sugars and vitamin C are lost rapidly and coarse fibers develop. It is, therefore, very important that asparagus be rapidly cooled to 40° or lower immediately after harvest, and that low temperatures be maintained during transit.

In packing, the butt ends of the spears are set on either sphagnum moss or water-retentive fiber pads in the crate to maintain crispness of the spears. While most of the asparagus spears packed are 9 inches long, there is a trend toward shipping shorter (7-inch) spears, thus avoiding the waste of shipping inedible butts which represent from one-quarter to one-third of the total market weight. Prepacking the shorter spears in film bags has been started on a small scale and will probably continue. For prepackaging it is essential that the bags be adequately ventilated (about ten to twenty 1/8-inch holes per 1-pound package) to avoid undesirably high CO<sub>2</sub> and low oxygen levels. This amount of ventilation will keep water loss low enough to avoid undesirable weight losses and to maintain turgidity. Preliminary tests indicate that asparagus prepackaged in properly ventilated film bags can be vacuum cooled successfully and without injury to the spears.

Bacterial soft rot is the most serious post-harvest decay, but it is effectively controlled by temperatures below 40°F. (94). Prolonged holding (10 days or more) at 32° to 34° may result in chilling damage. The longest storage life can be expected at about 36°.

**Beans (snap)**

Desired transit temperature, 45° to 50°F.

Snap beans held for 3 to 5 days below the desired temperature range (especially below 40°F.) are subject to chilling injury. This injury is manifested by pitting and russetting of the pods. If watery soft rot is present a transit temperature of 40° to 45° is desirable to retard this decay even though some chilling injury may occur.

Precooling of warm beans is essential. Hydrocooling is effective in quickly removing excess field heat but, because of the moisture left on the beans, russetting may result if they are held more than a total of 7 to 8 days. In considering the cumulative effects, both time in transit and in marketing must be included.

A number of decays affect snap beans in transit. The most important are watery soft rot, soil rot, bacterial blight, anthracnose, and bacterial soft rot (94). Reasonable control of the development of these decays in transit is afforded at temperatures around 45°F. Well-ventilated containers and open loads are recommended to permit adequate air circulation through the commodity, to remove heat of respiration in transit, and permit some drying of hydrocooled beans.

**Beets (bunched)**

Desired transit temperature, 32° to 40°F.

Bunched beets packed in wirebound crates must be package iced and also top iced to keep the tops in prime condition. The crates when loaded in the car should provide sidewall space for top ice to enter and blanket the load on the sides as well as the top.

Bacterial soft rot is most prevalent on the tops of bunched beets, rarely attacking the roots (93). The disease is greatly retarded by rapid cooling and by transit temperatures of 32° to 40°F.

**Broccoli**

Desired transit temperature, 32° to 36°F.

Broccoli has one of the highest respiration rates of any of the fruits or vegetables listed (table 1) and must, therefore, be handled under maximum refrigeration at all times. Exposure to temperatures above 50°F. for only a short time results in yellowing or browning of the buds with consequent reduction in salability. Emanation of ethylene by the broccoli is believed to be one cause of this yellowing (65). Moisture loss is also very high so broccoli should be kept wet by the use of package and top ice. The pony crate is the usual and best crate for shipping broccoli. The

use of larger containers frequently results in the development of excessive heat in the center of the crate. The pony crate is lined with waterproof paper and two layers of broccoli are packed between three layers of crushed ice ranging from 30 to 35 pounds per crate. Hydrocooling, if available, may be used for quick removal of field heat.

**Cabbage**

Desired transit temperature, 32° to 40°F.

While less perishable than some of the other leafy vegetables, field heat should be removed fairly quickly from early-crop cabbage by hydrocooling, vacuum cooling, or top icing in the car. A light top icing is desirable after hydrocooling or vacuum cooling since moisture loss in transit is the most serious problem. Late-crop cabbage is somewhat less susceptible to wilting but it, too, should be handled under proper temperatures. The use of fiberboard cartons or multiwall paper bags has not been very successful in warm weather except when a good vacuum-cooling job has been done and the shipment moved under Standard Refrigeration Service. During cool weather, nonpre-cooled shipments in these containers may move under Standard Refrigeration Service only. However, hydrocooling before packaging in such containers may be used to advantage to precool and moisten the loads. When top ice is used as a cooling medium for crated cabbage, 3- to 4-inch channels should be left between each row of crates, also next to the sidewalls, so that some of the top ice may settle down into the spaces. In addition to top ice, block ice can be placed on the floor racks in the centerline channel of the load to insure adequate refrigeration in this location. Cabbage harvested immediately after a rain during warm weather, especially if heavily fertilized, may develop excessive wastage during marketing.

Winter shipments of New York cabbage from storage may require protection against freezing by preheating the cars followed by heater service in transit.

The most important transit decays are bacterial soft rot, alternaria leaf spot, gray mold rot, and watery soft rot (95). Bacterial soft rot can be controlled and the development of other decays retarded, by temperatures below 40°F.

**Carrots**

Desired transit temperature, 32° to 38°F.

Carrots are packed in a variety of containers which will govern the transit protective service required. Most of the crop is now topped and

either prepackaged in film bags or packed in crates or in mesh or multiwall paper bags (5, 10). Hydrocooling of the roots, at least to 40° to 50° F., before prepackaging is highly desirable for all prepackaged carrots. Top ice should be used if hydrocooling is not available for loose or jumble-packed carrots shipped in crates. Bunched carrots, if not hydrocooled, should be cooled by package and top ice, plus bunker ice during hot weather. Prepackaging or packing in film-lined crates provides proper moisture retention. Carrots in fiberboard containers should be loaded with channels between rows or in a chimney pattern to provide adequate air circulation to remove heat of respiration in transit, and the appropriate amount of bunker ice used (no top ice) as indicated in table 8. Fan cars should be used with fans in operation.

The two most important decays are bacterial soft rot and watery soft rot, both of which are controlled by transit temperatures of 32° to 38° F. (94).

### Cauliflower

Desired transit temperature, 32° to 40°F.

Cooling cauliflower to the desired transit temperature range within a few hours after harvest is important to prevent wilting and poor arrival condition. Untrimmed cauliflower is packed in wooden crates, loaded in cars with channels between rows of crates, top iced, and forwarded with or without bunker ice depending on the weather at loading point and en route to market (60-62). Much of the trimmed, film-wrapped cauliflower from California is packed in ventilated cartons or in crates and vacuum cooled after packing. Other shippers prefer to hydrocool the trimmed heads before they are wrapped and packed. In either instance, the cars should be pre-iced and Standard Refrigeration Service used in transit. For loads that are well precooled, half-stage Standard Refrigeration Service may be adequate in moderate weather. Winter shipments of trimmed and film-wrapped cauliflower from Texas may be cooled satisfactorily with top ice only.

Principal decays in transit are bacterial soft rot of the curd and leaves, and brown rot (*Alternaria*) (95). Temperatures below 40° F. will control bacterial soft rot and retard development of the other decays.

### Celery

Desired transit temperature, 32° to 36°F.

Celery being a leafy vegetable is highly perishable and therefore should be cooled to 40°

F. or lower immediately after harvesting (94). Hydrocooling or vacuum cooling will quickly remove field heat of celery. When celery is packed in crates or water-resistant cartons, top icing immediately after loading continues the cooling obtained in the hydrocooler or vacuum cooler and furnishes the necessary moisture in transit to prevent wilting. The amount of top ice used will be governed by the season and destination. In loading, it is the practice in California to leave a space between the containers and the car sidewalls for filling with top ice. For long hauls in hot weather, retop icing in transit may be necessary. Bunker ice in conjunction with the top ice may be used during hot summer months.

Celery hearts prepackaged in perforated film bags can be hydrocooled before packaging, vacuum cooled after packaging, or room cooled. The shipping container is usually a fiberboard box. Standard Refrigeration Service and fan cars are necessary at all times to maintain desired transit temperatures, with salt added during extremely hot weather. Half-stage Standard Refrigeration Service may be adequate during mild weather.

Because of heavy losses from freezing damage reported in winter shipments to Canadian and northeastern destinations for both California and Florida celery, consideration should be given to the use of some classes of heater service. Both the shipper and the receiver should keep informed on weather conditions and order heater service when forecasts indicate low temperatures en route or at destination. All winter shipments (except celery hearts in fiberboard boxes) moving into northern territory should move with top ice only and dry bunkers in order that heaters may be placed in the bunkers if necessary, without the hazard and cost of removing bunker ice en route.

### Corn (sweet)

Desired transit temperature, 32° to 36°F.

Corn loses quality more quickly than any other vegetable or fruit after harvest if not properly handled. Sugar, which is largely responsible for the eating quality of corn, is lost very rapidly at ordinary room temperatures. Over 50 percent is lost in 24 hours. Quick cooling to 32° F. reduces this loss to only 20 percent in 4 days as shown in figure 18. Rapid cooling immediately after harvest is therefore imperative. Because of the high respiration rate of corn, maximum refrigeration is required in transit. Even under optimum conditions, corn gradually loses quality and should be moved without delay to the consumer. Heat removal is generally accomplished by hydro-

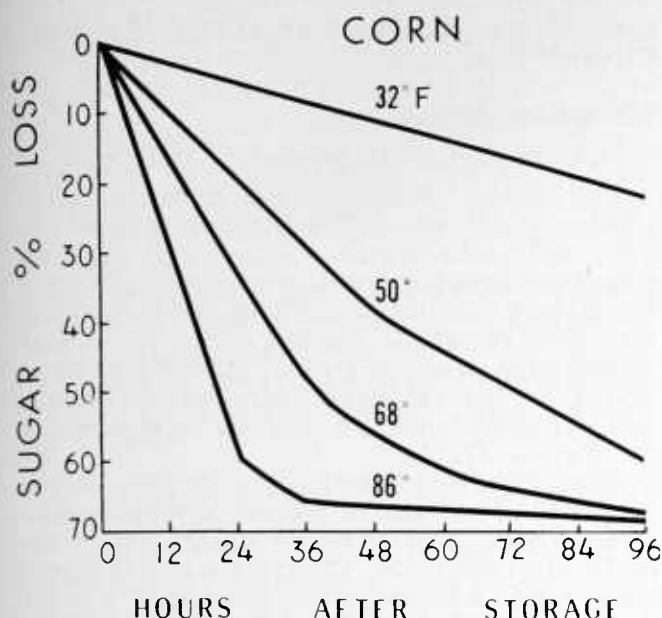


FIGURE 18.—Effect of temperature on sugar loss in sweet corn. (From Appleman, Chas. O., and John M. Arthur. *Carbohydrate Metabolism in Green Sweet Corn During Storage at Different Temperatures*. Jour. Agr. Res. 17: 137-152. 1919.)

cooling, but vacuum cooling is being used with some success in certain growing areas. Top icing is desirable for vacuum-cooled corn to replace moisture that may be removed from the husks during cooling. Because of the difficulty in removing the heat from ears of corn due to the insulating effect of the husks and the tight pack, the usual commercial hydrocooling or vacuum cooling does not reduce the temperature to the desired 32° (141). Therefore, immediately after precooling the corn must be loaded into pre-iced cars and top-iced. Standard Refrigeration Service is generally needed in addition to top ice, with 2 percent salt added to the bunker ice during hot weather.

To hasten cooling a channeled or open load should be used so that the top ice can settle between the containers. Space between the crates and sidewalls of the car is also desirable to provide a blanket of ice around the load. Retop icing in transit may be required in hot weather. Tests have shown that operating car fans results in lower and more uniform temperatures even with top ice on the load. With the proper amount of top ice, there is no danger of the commodity wilting or losing moisture in the car from the forced air circulation.

### Cucumbers

Desired transit temperature, 45° to 50°F.

Excess field heat should be removed from cucumbers within 24 hours to retard yellowing

and the development of certain decays in transit (95). Bacterial soft rot, watery soft rot, cottony leak, and black rot are especially stimulated by transit temperatures above 50° F. Cucumbers are susceptible to chilling injury at temperatures below 45°, particularly if subjected to such temperatures for 6 days or longer, and anthracnose rot frequently follows this injury.

Precooling is not usually required. A modified refrigeration service will provide the desired 45° to 50° F. temperature range. Waxing is a common practice for reduction of moisture loss and shriveling. Shipments moving to destinations in Northern States and Canada may require heater service during cold weather.

### Endive and escarole

Desired transit temperature, 33° to 36°F.

These leafy vegetables are similar to lettuce and are handled somewhat similarly. Because they are very perishable and have a high respiration rate, prompt refrigeration after harvesting is required. Hydrocooling is the usual commercial practice followed by top icing and bunker ice. However, vacuum cooling can also be effectively used. Transit decays are similar to those of lettuce (93).

### Lettuce

Desired transit temperature, 32° to 36°F.

Lettuce is one of the most perishable and easily damaged of the commercially shipped vegetables. Prompt cooling, suitable transit temperatures, and careful handling are required to prevent excessive deterioration in transit. Precooling to 33° to 35° F. should be done just as soon after cutting as possible. This is accomplished by vacuum cooling or with package ice and top ice. Cooling with forced air circulation in bunker-iced cars has occasionally been used in areas where harvest temperatures are low. Vacuum cooling provides the fastest cooling but it does not necessarily insure the lowest average transit temperature. The lettuce may be cooled by subjecting the packed container to the vacuum process before loading or, in some special installations, the entire load can be cooled simultaneously by placing the loaded refrigerator car in a vacuum chamber (fig. 25, page 54). This latter method has the advantage of not exposing the lettuce to outside temperatures after cooling which occurs when cooling precedes loading. Vacuum cooling is now being used for most of the commercial lettuce crop and is being expanded by the development and use of portable units (26).

The other method of cooling involves the use of 20 to 35 pounds of crushed ice in the con-

tainer with 4 or 5 dozen heads of lettuce. In addition to package ice, from 9,000 to 25,000 pounds of top ice is used per carload, depending on seasonal temperatures. Tests have shown that after the usual 16 to 18 hours required to cool the lettuce to 32° to 34° by this method, it is held consistently at this temperature by the package and top ice. Precooling of dry-pack lettuce with car or portable fans is slow, especially in the carton-pack.

The rapid development of vacuum-cooling facilities has enabled the wide use of fiberboard containers and the economies of field packing. The elimination of package ice in these containers has somewhat reduced bruising of the lettuce but has increased the problem of maintaining adequate refrigeration. It is important to thoroughly precool carton-packed lettuce because the insulation provided by the container and the usual solid load permit only slow cooling in transit (45). Transit refrigeration should be depended on only to remove the heat of respiration and heat leakage into the car.

For vacuum- and car-precooled lettuce shipments maximum refrigeration with bunker ice and at least 2 percent salt in transit is required during the summer months. Half-stage Standard Refrigeration Service or modified full-bunker services may be used at times during cool weather. Mechanically refrigerated cars with the thermostat set at 34° F. are also being used for vacuum-cooled lettuce (8, 13).

As with celery, considerable freezing damage has been found at destination in winter shipments of lettuce that moved in cars without heater service to Canadian markets. Cars moving through extremely cold weather should be protected by heaters under one of the "Protective Service Against Cold" rules appearing in the Perishable Protective Tariff. When cars are held on track at destination for more than a few hours, the car fans should be operated with portable holding motors to maintain uniform load temperatures, whether the car is under heat or refrigeration (69).

Bacterial soft rot is the most important transit disease of lettuce (92, 93). It commonly follows physiological disorders, such as tipburn. Bruising and mechanical injury, which may occur from rough handling or excessively tight packing, also increase susceptibility to soft rot. Careful handling and low temperatures provide the most effective control. Other important disorders which affect lettuce in transit are russet spotting, gray mold rot, tipburn, downy mildew, and watery soft rot. Some of these are caused by fungi and others are physiological disorders. They are all minimized by temperatures near 32° F. It is therefore evident that the continuous maintenance of nearly optimum

temperatures provides the best control of wastage in lettuce.

### Melons (cantaloups)

Desired transit temperature, 35° to 40°F.

The sooner cantaloups are precooled after picking, the longer will be their marketable life (85, 137). California, Texas, and Arizona cantaloups are precooled in *pre-iced* refrigerator cars by portable or car fans and bunker ice. Usually a calculated amount of top ice is used to speed the precooling (83). Either half-stage or full bunker Standard Refrigeration Service is provided in transit, depending on weather or destination (121).

Cantaloups should be thoroughly precooled to 35° to 40° F. to assure arrival in sound condition of hard-ripe or choice melons on transcontinental shipment. Cantaloups are now generally packed in nailed or wirebound wooden crates although the use of fiberboard cartons has increased in recent years. The amount of top ice supplied for precooling depends on the loading temperature of the melons (83). A recommended top icing schedule is shown in the tables following this section. It is essential that either the top ice be completely melted or the remaining ice be removed from the car on completion of precooling, for additional freight charges will be assessed on any ice remaining. Special precooling methods are necessary for melons in cartons as the use of top ice is not well adapted to this pack (133). Some shippers have used hydrocooling with apparent success. Fan cars are recommended for cantaloup shipments, not only because of the convenience of the built-in fans for precooling, but also because they provide more uniform temperatures in transit. The fans produce faster meltage of the top ice and also dry the melons and crates after the top ice is gone.

### Melons (honeydew)

Desired transit temperature, 45° to 50°F.

While a cool shipping temperature is desirable, honeydew melons do not require precooling. Prolonged exposure to temperatures below 40° F. is harmful (137). Honeydew melons from California, Texas, and Arizona are loaded in dry (noniced) refrigerator cars and treated for 18 to 24 hours before shipment with a low concentration of ethylene gas (500 to 1,000 p.p.m.) to accelerate degreening and other ripening processes. Pulp temperature must be 65° or above for significant response to ethylene. Often during hot weather the pulp temperature at loading is 90° or above, but this high temperature is not harmful during the gas treatment.

Initial icing is done after ethylene treatment, either at the loading shed or at the first icing station en route. Half-stage icing is commonly used under either Standard Refrigeration Service or modified icing rules, depending upon seasonal temperatures and degree of transit ripening desired (88). Fan cars are desirable for producing more uniform temperatures in transit.

HOWEVER, NO FANS SHOULD BE OPERATED DURING THE ETHYLENE GAS TREATMENT, DUE TO EXPLOSION HAZARD IF CONCENTRATIONS OF ETHYLENE SHOULD HAPPEN TO BE MUCH HIGHER THAN THOSE RECOMMENDED.

### Onions (dry)

Desired transit temperature, 32° to 40°F.

A temperature of 32° to 40° F. and low relative humidity, not above 70 to 75 percent, are desirable for onions to keep them dormant and prevent sprouting and decay.

During cool weather, Standard Ventilation is adequate for the transportation of onions from most areas. During warm summer weather, dry car loading followed by half-stage Standard Refrigeration Service is recommended for California. During winter weather, shipments originating in New York State will frequently require heater service, such as Carriers' Protective Service or Shippers' Specified Service. Pads on the floor racks of the car are desirable to minimize bruising in the bottom layer of sacks.

The commonest disease of onions is "neck rot," a gray mold rot that develops at the top of the bulb (94). The fungus can develop to some extent even at 32° F.

### Peas (green)

Desired transit temperature, 32° to 36°F.

During 1958, green peas showed the heaviest loss per car of any of the fresh fruits, melons, and vegetables, averaging \$155.32 per car in 642 carloads originated. While this loss includes container damage it does indicate the perishability of this vegetable which requires top speed in handling and maximum refrigeration in all phases of distribution. Green peas tend to lose a large part of their sugar content rapidly and hence, their flavor, unless promptly cooled to near 32° F. Because of the high respiration rate of peas, they should be maintained near 32° during transit and distribution. Hydrocooling or vacuum cooling and loading in pre-iced cars is desirable, followed by top icing plus Standard Refrigeration Service in transit.

The most important decays that develop in

transit are bacterial soft rot, gray mold rot, and watery soft rot, all greatly retarded by the low transit temperatures recommended (94).

### Peppers (sweet)

Desired transit temperature, 45° to 50°F.

Sweet or bell peppers are subject to chilling injury when held at temperatures below 45° F. They should therefore be shipped at moderate temperatures. The symptoms of chilling injury are surface pitting and discoloration near the calyx, followed by such decays as alternaria rot and gray mold rot. Temperatures above 50° not only increase the development of bacterial soft rot and Rhizopus rot, but also favor ripening (96).

Modified refrigeration service is usually all that is necessary. The amount of ice needed depends upon the temperature of the peppers at loading. During winter months, some refrigeration service in conjunction with ventilation may be necessary during the early part of the transit period, followed by heater service in colder areas.

### Potatoes

Desired transit temperatures: Early crop, 55° to 65°F.; late crop, 40° to 50°; for chipping, early crop, 60° to 70°; for chipping, late crop, 50° to 65°.

Potatoes are often erroneously treated as "hardware" with not enough regard for careful handling or optimum temperature (111). This results in heavy losses from sprouting, decay, overheating, freezing, and mechanical damage. While temperature is not generally a vital factor in the transportation of sound, mature potatoes, decay originating at bruises, cuts, or skinned areas, or induced by heat injury before or during harvest, is a serious problem and must be controlled by relatively low temperatures. Like most fruits and vegetables, potatoes with unbroken skins are substantially protected against the invasion of decay-producing organisms; are resistant to moisture loss, and are largely immune to tissue (surface) browning. Fortunately, potato tubers have the ability to produce suberin and wound periderm (essentially new skin). Thus skinned and feathered surfaces may be healed if provided the proper environment. The optimum temperature range for healing is from 65° to 75° F. Below 50° healing proceeds slowly, and no measurable protection develops at temperatures below 40°. High humidity is essential to periderm formation.

Preventing physical injuries by careful handling from harvesting to the retail outlet is very important. Padding over floor racks of cars is essential to protect the bottom layer of potatoes in bags from scuffing and bruising in transit (70, 132). With the current availability of special per-car freight rates in certain districts, heavier loading is being encouraged. With the resulting higher stacking, more weight is imposed on bottom layers of bags, thus increasing the possibility of physical damage. However, no information has been received that indicates much greater damage occurs due to the increased weight, even for the 50,000-pound load. Care must be taken with these high loads not to obstruct the top bunker openings which would impair needed air circulation. Proper stacking is important to prevent shifting. Winter shipments must be loaded so as to minimize the danger of even slight freezing.

The principal decay of potatoes in transit is bacterial soft rot (97), which is most prevalent during warmer weather. Following cool, wet growing seasons, late blight may cause decay in transit. Both are held in check fairly well at temperatures below 60°F.

Potatoes may be divided into early crop and late crop. Each requires somewhat different protection in transit.

*Early-crop.*—These are “new” or “early” potatoes which are shipped immediately after harvesting and are generally not fully matured. This immaturity results in varying amounts of skinning or feathering during washing, sorting, and sizing; therefore, conditions in transit must be provided for the formation of new skin to minimize the development of decay and surface browning. A moderate temperature of about 60°F. in transit is desirable for these potatoes. This temperature, while slightly below the optimum for periderm formation, is effective in preventing development of decay organisms. The desired temperature can be achieved by modified icing services, or sometimes by ventilation service alone (6, 9, 115). Properly used, these services will provide the desired temperatures for healing and reduce protective service costs as compared with Standard Refrigeration Service. Early-crop potatoes should be loaded so as to permit cooling of the load. Precooling is not necessary unless the potatoes are unusually warm at loading, and it is not desirable to precool the load below 55° to 60°. The recommended refrigeration services presented in table 8 are based in part on the loading temperatures of the potatoes. Ventilation can be used to aid in drying, if weather permits. This is particularly true of the Florida crop moved during the winter.

*Late-crop.*—These potatoes are harvested at a mature stage in summer and fall, a large percentage being placed in storage. Transit temperatures lower than the 55° to 65°F. recommended for early potatoes are not injurious for freshly harvested late potatoes as skin healing is not an important factor. During hot weather, some refrigeration to retard decay is essential for freshly harvested potatoes. Specified refrigeration services are compulsory during the summer and early fall for certain areas in Idaho, Oregon, and Washington, as shown in the Perishable Protective Tariff under Rule 200. The governing dates and refrigeration services applicable thereto are prescribed by the shippers' agencies and are subject to revision each year. As a consequence, such data in table 8 may differ somewhat from that for the current year. Ventilation service is usually sufficient during cool fall weather from most of the late-crop-producing areas. From November 16 to but not including March 1, Carriers' Protective Service is compulsory in Heater Territory (Part 1). Special Heater Protective Service with LF heaters (fig. 6) is available for potato shipments originating in Special Heater Protective Service Territory, and heater thermostats should be set at 40°. Winter shipments from Maine move under Shippers' Protective Service and it is customary to set the thermostats on LF heaters at 45° (101).

Protection against freezing in transit is the greatest problem in moving table-stock potatoes of the late crop to market. Studies are now being conducted on shipping precut potato seed under appropriate heater service (50). In addition to adequate transit heater service, it is also essential to preheat cars before loading, provide protection during loading with appropriate canvas door shields or loading tunnel (fig. 19) (22), and use proper loading methods (46, 56). The “pyramid through load” method, as recommended by the Freight Loading and Container Bureau of the AAR, is the most satisfactory type of load (fig. 20). No bags are in contact with the sidewalls, thus minimizing chance for freezing in lower layers and side rows. The bottom two or three layers of loads containing small-consumer bags should also be loaded to avoid contact with the sidewalls as shown in figure 21. Paper may be used on sidewalls to prevent scuffing and chafing of consumer-size bags but is of no value as insulation (70). If paper or pads are used on the floor racks, space must be left at the juncture of the racks and sidewalls to permit air circulation around the load. Car fans should always be operated. While shipments are under heater service, fan operation will prevent cold pockets



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FIGURE 19.—Canvas loading tunnel between car doorway opening and potato storage to prevent loss of temperature during loading.

on the floor and overheating in the top of the load. For Maine potatoes shipped at the end of the storage period in late spring, one railroad provides free initial icing up to 5,000 pounds.

*Potatoes for chipping.*—Early-crop potatoes for chipping require a transit temperature between 60° and 70° F. While 70° is closer to the desired optimum, the presence of decay may require temperatures nearer 60°. Ventilation service only may be used for such potatoes but some modified refrigeration service with vents open may be required in hot weather. Early-crop chipping potatoes are less likely to develop decay in transit if shipped unwashed.

Late-crop potatoes for chipping require higher temperature in transit than those for table stock so that sugar will not accumulate in the potatoes during transit, and reconditioning can proceed in potatoes which have been stored at low temperature.

When LF heaters are used for late-crop chipping potatoes which were stored around 40° F., the heater thermostats should be set at 60° in order to promote some conditioning in transit

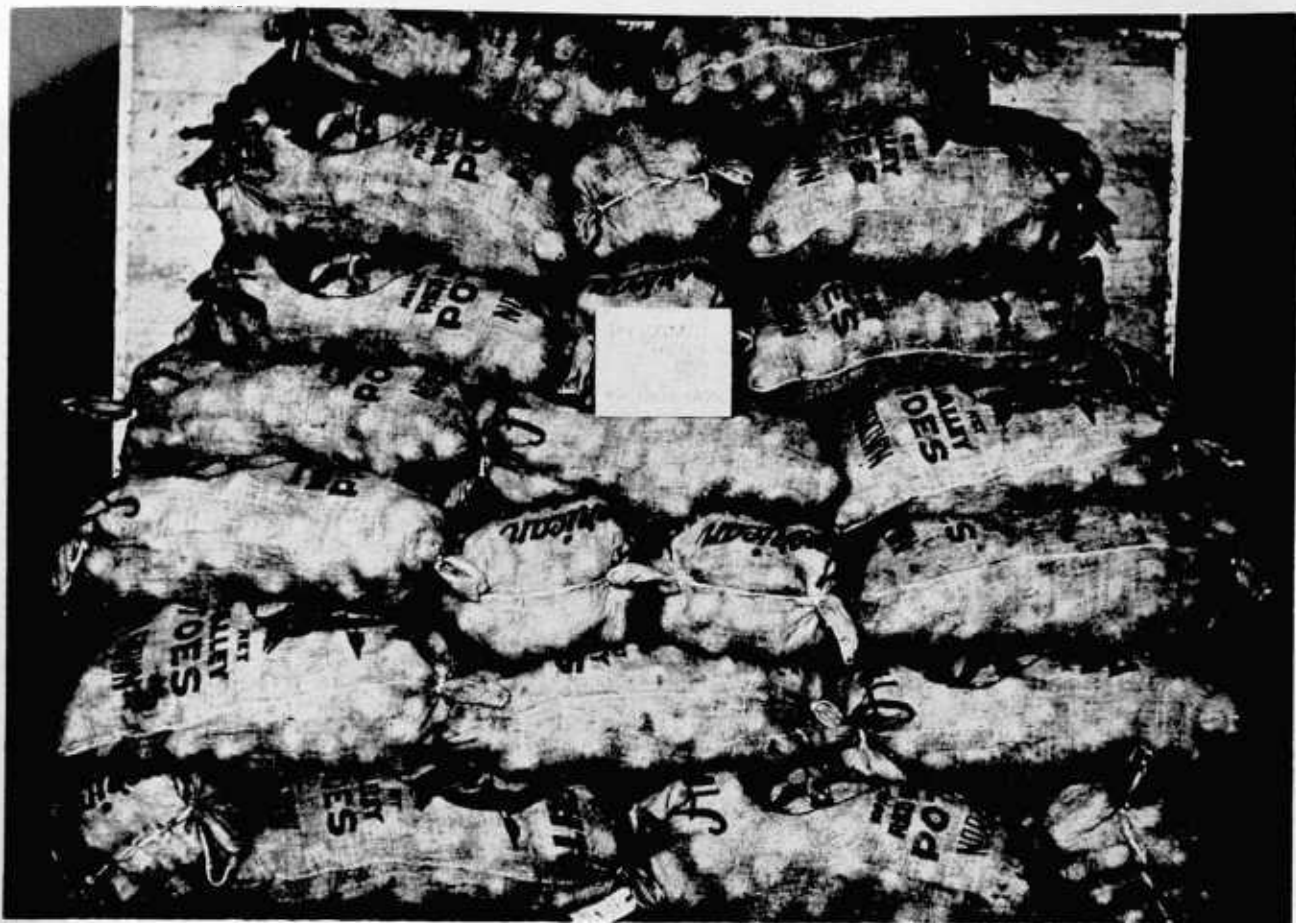
(24). However, chipping potatoes coming out of 50° to 55° storage may be transported at the same temperature (50° to 55°).

Consideration is being given by the carriers and carlines, to a special arrangement that will permit the use of LF heaters east of St. Louis and Chicago in shipments of chipping potatoes originating in Special Heater Protective Service Territory.

### Radishes

Desired transit temperature, 32° to 40° F.

Practically all radishes are now topped and prepacked in small consumer-size film bags and shipped in wirebound crates or baskets. Hydrocooling is recommended, followed by top icing of the load. In addition, bunker icing should be used in warm weather. Bunched radishes should also be top iced to prevent yellowing, wilting, and decay of the tops. Bacterial soft rot is the principal decay that may occur in transit. Bagged and bunched radishes are both affected by a black spotting of the surface which can be effectively controlled by



BN-10160

FIGURE 20.—One form of recommended compact "pyramid" load for 100-lb. bags of potatoes. (Note space between car walls and potatoes.)

a temperature of 50° F. or lower (95). An open or channel load should be used to permit the top ice to settle down between the containers throughout the load for maximum refrigeration efficiency.

### Spinach

Desired transit temperature, 32° to 40° F.

This leafy vegetable has a very high rate of respiration (table 1). For this reason, the packing of spinach in fiberboard cartons or multiwall paper bags has been found unsatisfactory because of the difficulty in removing the respiratory heat from these containers in transit. Containers such as crates or baskets that provide more adequate ventilation and are adaptable to package and top icing are usually used and are recommended. While vacuum cooling of this commodity might be desirable, the general practice is to cool with package ice and top ice in conjunction with modified bunker icing.

The more important diseases that affect

spinach are bacterial soft rot, anthracnose, downy mildew, and leaf spot (93). Temperatures from 32° to 40° F. should be maintained in transit in order to inhibit these decays, retain good green color and crispness, and control the rate of respiration.

### Sweetpotatoes

Desired transit temperature, 55° to 60° F.

Sweetpotatoes that are to be marketed promptly should be kept at temperatures above 55° F. Roots that are to be stored should be cured at 85° with high humidity for about 1 week and storage temperatures then maintained between 55° and 60°. Sweetpotatoes are more subject to chilling injury than is generally thought (68). Such injury increases the possibility of decay, reduces culinary quality, and impairs appearance. Subjecting roots to temperatures of 50° or below for only a few days may seriously affect their storage life. The chilling injury often does not become evident immediately after exposure to low tempera-



BN-10154

FIGURE 21.—Method of loading bottom layers of bagged potatoes away from car sidewalls to minimize danger of freezing damage.

tures but may become apparent 2 or 3 weeks later. Principal transit decays are *Rhizopus* rot and black rot (93).

Proper transit temperatures can usually be obtained by Special Ventilation Service, closing vents below 55° F. and opening them above 55°. Shipments to northern markets in winter months should be protected by Special Ventilation in conjunction with heater service.

#### Tomatoes (mature-green)

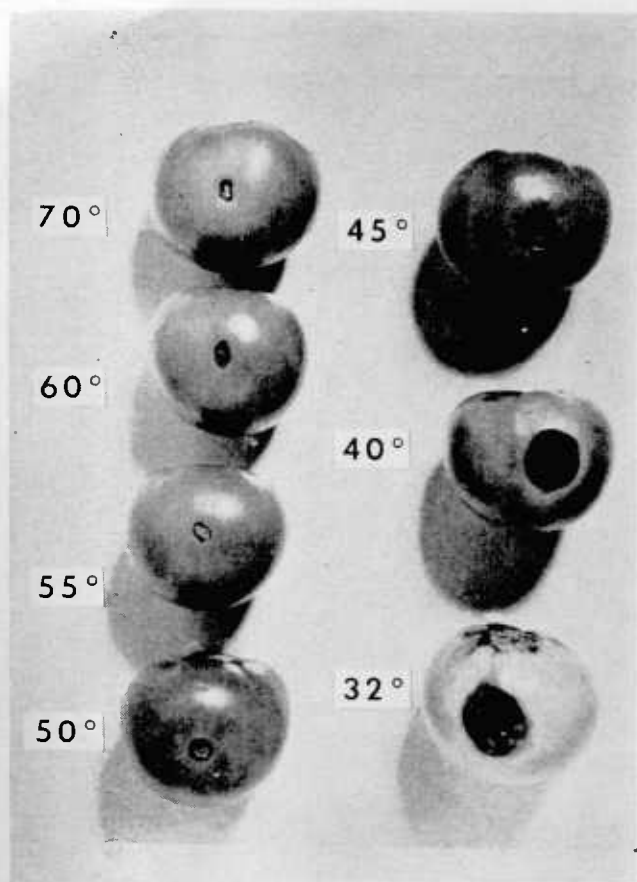
Desired transit temperature, 55° to 65° F.

Tomatoes are subject to chilling injury. Best results are obtained when mature-green tomatoes are kept between 55° and 65° F. (1, 76, 126). Although tomatoes which have had no field chilling can withstand low, but not freezing, temperatures for a few days without becoming seriously injured, it is not advisable for the fruit temperatures to be lower than 50° during transit (77). This precaution is taken for several reasons: (1) transit temperatures below 50° retard ripening even after the tomatoes are placed at favorable ripening temperatures; (2) chilling injury is cumulative (75,

78), and although tomatoes may escape damage from a period of low field or transit temperatures alone, they may be seriously damaged if one exposure follows the other; and (3) exposure to low temperatures short of serious injury may cause numerous dark skin blemishes that detract from the appearance of the fruit. Chilling injury ordinarily cannot be detected at the time the tomatoes are unloaded from the cars.

Most of the decay of tomatoes injured by low temperatures is caused by a fungus, *Alternaria* sp. (77, 96), which ordinarily will not attack tomatoes that have been kept at moderate temperatures. The influence of temperature on the susceptibility of mature-green tomatoes to this rot is shown in figure 22.

Excessive field heat should be removed quickly, but additional refrigeration should be used sparingly and in line with calculated needs. A schedule of modified icing services for mature-green tomatoes, based on their loading temperature, appears in tables 8 and 9 (see also 7, 11, 12, 57, 84). These services are predicated on the use of fan cars, with the fans in operation from origin to destination and



BN-10155

FIGURE 22.—Influence of temperature on susceptibility of mature-green tomatoes to alternaria rot. Fruits shown were inoculated and held at indicated temperatures for 14 days and then held 14 days longer at 60° F.

vents kept closed after icing. At certain times of the year when outside temperatures are cool, Standard Ventilation will suffice. If shipments from Florida encounter cold weather, heater service with LF heaters will be necessary under Shippers' Specified Service (Rule 520). On late fall shipments from California and winter shipments from Texas and Mexico, Special Heater Protective Service with LF heaters (Rule 580) may be used, followed by Shippers' Specified Service with LF heaters (Rule 514) if so required, upon entry into the territory applying to each rule. The thermostat on LF heaters should be set at 50° F. and car vents kept closed during heater service.

### Tomatoes (pink)

Desired transit temperature, 45° to 50° F.

Tomatoes picked after some color has developed are usually referred to as "pink" tomatoes but they are sometimes erroneously termed "vine ripened" tomatoes. Precooling is usually

needed to remove excessive field heat from such tomatoes. The desired temperature to which they should be precooled depends on the stage of color development and the distance to market. In a 3- to 4-day transit period, fruits showing less than  $\frac{1}{3}$  color at harvest need not be precooled below 60° F. providing the transit temperature is held around 45° to 50°. Tomatoes harvested with more than  $\frac{1}{3}$  color should be precooled to 50° and transported at 50°, if transit ripening is to be held to 50 to 70 percent color during a period of 4 days (76). Recommended modified icing services for pink tomatoes, based on the use of fan cars, are presented in table 8. The thermostat on LF heaters should be set at 47½° and car vents kept closed during heater service.

### Frozen fruits and vegetables

Desired temperature, 0° F. and lower.

The inherent quality of frozen fruits and vegetables is dependent on prompt freezing to the recommended temperature and then maintaining this temperature *continuously* until the product is used by the consumer. This requires the most careful handling at all points in the chain of distribution: packing, transportation, subsequent storage, wholesaler, retailer and consumer (124). Unless temperatures no higher than 0° F. are maintained constantly, original quality is affected. Studies by the United States Department of Agriculture have shown that quality lost by exposure to temperatures above the optimum cannot be recovered (2). This quality loss accumulates or increases during each interval that the temperature is above the optimum. In other words, recooling a frozen product to zero or lower does not correct previous temperature damage or restore the original quality. As a result of studies of this nature, the National Association of Frozen Food Packers has recommended that all frozen products be transported no higher than 0°.

Every precaution should be taken in loading and unloading frozen commodities to prevent *any* rise in temperature. Cars should be thoroughly precooled to zero before loading if possible. All loading and unloading should be done inside the cold storage warehouse, or suitable loading tunnels or door shields should be provided. If there is any delay, car doors should be closed and the mechanical refrigeration unit operated during the interim. Most frozen foods moved by rail are now shipped in mechanically refrigerated cars in which the thermostat is set at zero.

Heavily insulated, iced cars (either end bunker or overhead bunker types) are used to a limited extent for frozen foods, moving under Standard Refrigeration Service plus 30 percent

salt. The cars should be pre-iced from 24 to 36 hours before loading in order to become thoroughly precooled. They should have 6 inches or more of insulation and be in good condition. End-bunker iced cars should be equipped with built-in fans in good working order. The commodity temperature in storage before loading should be at or below 0° F. Temperature

of a number of packages should be checked by means of a reliable hand or insert thermometer during loading (31). Air circulation around the load is necessary to prevent the heat passing through car walls from raising commodity temperatures during transit. Wall flues or racks should be provided and car fans kept in operation to insure forced-air movement.

## METHODS OF CONTROLLING TRANSIT ENVIRONMENT

The necessity for providing favorable environments for fruits and vegetables after harvest has been explained. This section describes the available methods of heating and cooling that can be used to obtain these conditions in transit. Some of the basic principles of heat transfer are discussed in the following paragraphs to provide shippers with a better understanding of the subject.

### Refrigeration Principles

#### Definition

What is refrigeration? It is the process of removing heat from a substance, or of lowering its temperature and maintaining it at a desired level. What, then, is heat—or cold? Heat is a form of energy that is possessed by all matter. Its level is measured by temperature. Cold is merely an expression of a relatively low level of heat and has no real substance. Therefore, we cool an object by removing heat from it, not by pumping “cold” into it. Heat always flows naturally from a warmer to a cooler body. For instance, when you place your hand near or on a cold object it feels as if cold was coming from the object. Actually, what is felt is heat leaving the hand. When ice is placed in water, the water is cooled because the ice absorbs heat from the water. Heat is measurable and can be added to or removed from a body to raise or lower its temperature. It is commonly measured in British thermal units (B.t.u.). One B.t.u. is defined as the quantity of heat required to raise the temperature of 1 pound of water 1° F. The ratio of heat required to raise the temperature of a given weight of any other material (such as fruits and vegetables) to that required to cause an equivalent rise in the same weight of water is called its specific heat. This is discussed under refrigeration-load calculations.

#### Sources of refrigeration

To provide the necessary means for absorbing heat from the commodities to be cooled we use ice, ice and salt, solid carbon dioxide (dry ice), evaporation, mechanical refrigeration, and cold outside air (ventilation).

*Ice.*—When water freezes to ice at 32° F., a considerable amount of heat must be removed to change it from the liquid to the solid stage. This heat is called “latent” heat because it is not felt or apparent as the temperature remains at 32° during this change. A total of 144 B.t.u. must be removed to freeze 1 pound of water and the same amount must be added to melt 1 pound of ice. Therefore, 144 B.t.u. must be absorbed from surrounding air and objects for every pound of ice melted. This is why ice is such a good source of refrigeration for many uses above 32°. The standard ton of refrigeration represents the amount of heat required to melt 1 ton of ice in 1 day and is 288,000 B.t.u. (144 B.t.u. × 2,000 lb.) or 12,000 B.t.u. per hour. Although ice freezes (and melts) at 32° its temperature can get much lower while it is being made or while it is stored at low temperatures. If abnormally cold ice is placed in packages or used as top ice, it may cause freezing damage when it comes in contact with produce, especially the leafy vegetables.

*Ice and salt.*—Since most of the heat-absorbing ability of ice occurs at 32° F., we must add salt to the ice if we want lower temperatures or a more rapid cooling rate. When salt is added to ice, it causes the ice to melt faster. This means it absorbs heat faster from its surroundings than normally, resulting in faster cooling and a lower ultimate temperature than can be obtained from ice alone. In addition, the salt lowers the freezing point of the water melted from the ice, and the resulting brine temperature is below 32°. The lowest theoretical temperature of ice, salt, and brine that can be obtained is –6°, but because it is not possible to obtain a perfect mixture of ice and salt in practice, +5° is about the lowest temperature obtainable. This is obtained when the amount of salt added is 30 percent, by weight, of the ice. Lesser amounts of salt give correspondingly higher temperatures. Proper mixing of the salt with the ice is necessary to get maximum refrigeration.

*Carbon dioxide (dry ice).*—Solid carbon dioxide has a very low temperature (–109°F.) which is most suitable for frozen foods. Unless used in specially designed bunkers or other con-

tainers, its cost is excessive. It is unusual in that it does not melt but passes directly from the solid to the gaseous state. The latent heat required for this change of state is approximately 260 B.t.u. per pound or somewhat less than twice that of water ice. In shipments of some highly perishable fruits, such as strawberries and cherries, dry ice is placed in the loading space or in car bunkers with the water ice to build up a concentration of CO<sub>2</sub> gas in the car as a deterrent to spoilage and ripening in transit.

*Mechanical refrigeration.*—This may be described as a mechanical heat pump in which the heat is picked up in the space to be cooled by the refrigerant in the cooling coils or evaporator. It is then pumped outside by means of the compressor, to the condenser where it is dissipated to the outside air or cooling water. The capacity of the system depends on the size of the compressor (how much it can pump), the size of the cooling coils (how much heat they can absorb), and the size of the condenser (how much heat it can give up to the outside air or cooling water). When mechanical refrigeration was first developed it was natural to compare its cooling effect with that of ice. Hence, if a system could absorb as much heat in 1 day as a ton of ice (288,000 B.t.u.) it was said to have a capacity of 1 ton. This expression is still used generally in rating refrigerating machines, but is usually expressed in B.t.u. per hour (12,000 for 1 ton). Because mechanical units in refrigerator cars can easily produce temperatures well below the freezing point, they have been used primarily for frozen foods which require

temperatures of zero and below in transit. However, mechanically equipped cars designed to operate at a wide range of temperatures with thermostatic control are now in service for nonfrozen commodities including fresh produce as well as frozen foods (4).

### The heat load

Now that we have briefly discussed the source of refrigeration available for cooling, let us determine the heat to be removed. The heat load is composed of (1) sensible or field heat of the commodity, packages, and car structure, (2) the heat of respiration of the commodity, (3) heat leakage into the refrigerator car during transit, and (4) heat generated by the operation of car fans.

*Field heat* ( $H_s$ ) is that which must be removed to lower the temperature from that at loading to the desired transit temperature. It involves the specific heats (Sp.ht.) of product and containers (see table 6), the weight of product and containers, and the temperature difference (TD).

$$H_s = \text{Sp.ht.} \times \text{weight} \times \text{TD} = \text{B.t.u.}$$

*Car body heat* is the heat ( $H_c$ ) to be removed from the walls, floor, ceiling, and insulation to cool the interior of the car. As a rough estimate for the average 40-foot refrigerator car, the total weight of car-body items to be cooled may be assumed as 8,800 pounds with a specific heat of 0.40 B.t.u./lb.

$$H_c = 8,800 \times 0.40 \times \text{TD} = \text{B.t.u.}$$

TABLE 6.—Specific heat above freezing of certain fruits and vegetables<sup>1</sup>

Fresh fruit	Specific heat	Fresh vegetables	Specific heat
	B.t.u./lb.		B.t.u./lb.
Apples.....	0.87	Asparagus.....	0.94
Apricots.....	.88	Beans, snap.....	.91
Avocados.....	.72	Beets (roots).....	.90
Bananas.....	.80	Broccoli (sprouting).....	.92
Cherries, sweet.....	.87	Cabbage, late.....	.94
Citrus:		Carrots (roots).....	.90
Grapefruit.....	.91	Cauliflower.....	.93
Lemons.....	.92	Celery.....	.95
Limes.....	.89	Corn, sweet.....	.79
Oranges.....	.90	Cucumbers.....	.97
Tangerines.....	.90	Endive and escarole.....	.94
Cranberries.....	.90	Lettuce.....	.96
Dates, dried.....	.36	Melons.....	.94
Figs, fresh.....	.82	Onions, dry.....	.90
Grapes.....	.86	Peas, green.....	.79
Peaches.....	.90	Peppers, sweet.....	.94
Pears.....	.86	Potatoes.....	.82
Pineapples, ripe.....	.88	Radishes.....	.95
Plums (fresh prunes).....	.88	Spinach.....	.94
Strawberries.....	.92	Sweetpotatoes.....	.75
		Tomatoes.....	.95

<sup>1</sup>Amer. Soc. Refrig. Engin., Refrig. Appl. Data Book, chap. 23. 1959.

*Heat of respiration* ( $H_R$ ) is determined from table 1 which gives the amount evolved per ton in 24 hours at different temperatures (30). The amount of heat produced in transit involves two time periods, one covering the initial cooling period, and the other the balance of the transit period after the temperature has stabilized. In calculating the heat evolved by respiration, the average temperature for each of these periods is used. The time involved in the first period will vary depending on whether cooling is done before shipment or in transit. Precooling in the car (before shipment) may require from 6 to 20 hours, while cooling in transit may take from 1 to 3 days. Total heat of respiration in car equals  $H_{RP} + H_{RT}$ .

$H_{RP}$  = Respiration rate (at average temperature during initial cooling)  $\times$  time  $\times$  Wt. (tons) = B.t.u.

$H_{RT}$  = Respiration rate (at average transit temperature after cooling)  $\times$  No. of days  $\times$  Wt. (tons) = B.t.u.

*Heat leakage* ( $H_L$ ) is the heat that passes through the car structure. It varies with the amount and condition of insulation and air leakage into the car, as well as the difference between temperatures inside and outside the car. During short precooling periods the heat leakage is generally not great enough to be included in calculations. The rate of heat flow through the walls is called the "conductance" (C), and is expressed in B.t.u. per degree temperature difference per hour. For rough calculations, the following conductances for the average 40-foot refrigerator car with 1,430 square feet of surface area were determined from tests conducted by the Association of American Railroads (108):

Insulation thickness (Inches)	Conductance (B.t.u./°F./hr.)
3-3½	128.5
4-4½	117.0
5-6	98.5
6-7	90.0

To calculate heat leakage ( $H_L$ ) in transit,

$$H_L = C \times TD \times \text{time (hr.)} = \text{B.t.u.}$$

*Car fans* generate a certain amount of heat ( $H_F$ ) when operating. This heat should be considered when calculating the refrigeration load. During precooling, car fans or portable precooling fans move approximately the same volume of air as the car fan output at 50 m.p.h. car speed, with a heat input of approximately 5,000 B.t.u. per hour ( $H_{FP}$ ). During transit, fans operate only when the car is moving, so it is necessary to estimate what percentage of the time a car is moving and its average speed during the transit period. Assume that the car is moving 60 percent of the time at an average

speed of 35 m.p.h. At this speed, fan heat output is around 2,000 B.t.u. per hour per car ( $H_{FT}$ ).

$$H_{FP} = 5,000 \times \text{precooling time (hr.)} = \text{B.t.u.}$$

$$H_{FT} = 2,000 \times .60 (\%) \times \text{transit time (hr.)} = \text{B.t.u.}$$

*Heat load during precooling* ( $H_P$ ) can be shown as follows:

$$H_P = H_S \text{ (field heat)} + H_{RP} \text{ (respiration)} + H_C \text{ (car structure)} + H_{FP} \text{ (fans)}$$

*Heat load during transit* after initial cooling includes somewhat different sources:

$$H_T = H_{RT} + H_L \text{ (leakage)} + H_{FT} \text{ (fan)}$$

These heat loads are all in B.t.u. For the ice requirement in pounds, divide by 144.

### Heat transfer

So far, we have been discussing the heat that must be removed by a source of refrigeration. How is this heat transferred from the warm load to the refrigerating surface? Heat can move directly from a warm to a cold body by radiation, by direct contact (conduction), or by means of an intermediate medium such as air (convection). Radiation of heat is not an important means of cooling in refrigerator cars. Cooling by direct contact (conduction) is accomplished when top or package ice is used, or when cold water is used for hydrocooling. Cooling a load in a car is usually done by air which moves either by natural convection or is forced by fans. The rate of heat transfer (cooling) is speeded up considerably by forced circulation of the air with fans or moving large volumes of ice water by means of pumps. High velocity of air is also desirable for the rapid transfer of heat from the commodity to the cooling medium. This is why cooling is more rapid and temperatures more uniform in cars with fans operating than in cars without fans (69, 80).

### Sample Refrigeration Load Calculations

Assume that a car is loaded with oranges in 4/5-bushel wirebound crates:

$$\begin{aligned} \text{Load} &= 1,056 \text{ crates} \\ \text{Net Wt. fruit} &= 45.0 \text{ lb. per crate} \\ &= 47,600 \text{ lb. total.} \\ \text{Net Wt. crates} &= 3.5 \text{ lb. each} \\ &= 3,700 \text{ lb. total.} \\ \text{Sp.ht. fruit} &= 0.90 \text{ B.t.u./lb./°F.} \\ \text{Sp.ht. crates} &= 0.40 \text{ B.t.u./lb./°F.} \\ \text{Initial temp. (T}_1\text{)} &= 80^\circ \\ \text{Final temp. (T}_2\text{)} &= 50^\circ \\ \text{TD} = \text{T}_1 - \text{T}_2 &= 80 - 50 \\ &= 30^\circ \end{aligned}$$

Car conductance (4 to

$$4\frac{1}{2} \text{ in. insulation}) = 117.0 \text{ B.t.u./°F./hr.}$$

## 1. For precooling in 8 hours:

$$\text{Field heat } (H_s) = \text{Wt.} \times \text{Sp.ht.} \times \text{TD}$$

$$H_s \text{ (oranges)} = 47,600 \times 0.90 \times 30 = 1,285,200 \text{ B.t.u.}$$

$$H_s \text{ (crates)} = 3,700 \times 0.40 \times 30 = 44,400 \text{ B.t.u.}$$

$$1,285,200 + 44,400 = 1,329,600 \text{ B.t.u.}$$

Ice requirement: 9,233 lb.

$$\begin{aligned} \text{Car body heat } (H_c) &= 8,800 \times \text{Sp.ht.} \times \text{TD} \\ &= 8,800 \times 0.40 \times 30 \\ &= 105,600 \text{ B.t.u.} \end{aligned}$$

Ice requirement: 733 lb.

$$\text{Heat of respiration } (H_{RP}) = \text{Respiration rate} \times \text{hours} \times \text{Wt.}$$

$$\text{Av. temp. during precooling} = \frac{80 + 50}{2} = 65^\circ$$

$$\text{Respiration rate at } 65^\circ = 167 \text{ B.t.u./ton/hour}$$

$$H_{RP} = 167 \times 8 \times \frac{47,600}{2,000} = 31,797 \text{ B.t.u.}$$

Ice requirement: 221 lb.

$$\begin{aligned} \text{Precooling fan heat } (H_{FP}) &= \text{heat per hour} \times \text{hours} \\ &= 5,000 \times 8 \\ &= 40,000 \text{ B.t.u.} \end{aligned}$$

Ice requirement: 278 lb.

Total precooling load:

$$\begin{aligned} H_s &= 1,329,600 \text{ B.t.u.} \\ H_c &= 105,600 \\ H_{RP} &= 31,797 \\ H_{FP} &= 40,000 \\ H_s + H_c + H_{RP} + H_{FP} &= 1,506,997 \text{ B.t.u.} \end{aligned}$$

Total precooling ice requirement:

$$\begin{aligned} H_s &= 9,233 \text{ lb.} \\ H_c &= 733 \\ H_{RP} &= 221 \\ H_{FP} &= 278 \end{aligned}$$

$$H_s + H_c + H_{RP} + H_{FP} = 10,465 \text{ lb.}$$

Ice meltage: 1,308 lb. per hour.

To cool this load from 80° to 50° F. would therefore require nearly 10,500 pounds of ice which amounts to practically all the ice in both bunkers. From a practical standpoint the car should be re-iced about half-way through precooling to maintain a satisfactory cooling rate. These figures represent the theoretical heat transfer and probably exceed what occurs in actual practice. The time required to cool this load would depend on the volume of air moved and the distribution of air through the load.

## 2. Transit refrigeration for the precooled load:

Assumptions:

Load temperature = 50°

Transit time after precooling = 5 days (120 hr.)

Av. outside temp. = 75°

$$\text{Heat of respiration at } 50^\circ = 2,600 \text{ B.t.u./ton/day}$$

$$\text{TD} = 75 - 50 = 25^\circ$$

$$\text{Av. car speed} = 35 \text{ m.p.h.}$$

$$\text{Car fan operation} = 60\% \times 120 \text{ hr.} = 72 \text{ hr.}$$

$$\text{Refrigeration load} = H_{RT} + H_L + H_{FT}$$

$$\text{Heat of respiration } (H_{RT}) = \text{Respiration rate} \times \text{hours} \times \text{Wt.}$$

$$\text{Respiration rate at } 50^\circ = 2,600 \text{ B.t.u./ton/day}$$

$$H_{RT} = 2,600 \times \frac{47,600}{2,000} \times 5 = 309,400 \text{ B.t.u.}$$

Ice requirement: 2,149 lb.

$$\begin{aligned} \text{Heat leakage } (H_L) &= \text{Conductance} \times \text{TD} \times \text{hours} \\ &= 117.0 \times 25 \times 120 \\ &= 351,000 \text{ B.t.u.} \end{aligned}$$

Ice requirement: 2,437 lb.

$$\begin{aligned} \text{Car fans (transit)} (H_{FT}) &= \text{Heat output} \times \text{fan operating time} \\ &= 2,000 \times 72 \\ &= 144,000 \text{ B.t.u.} \end{aligned}$$

Ice requirement: 1,000 lb.

Total refrigeration load:

$$\begin{aligned} H_{RT} &= 309,400 \\ H_L &= 351,000 \\ H_{FT} &= 144,000 \\ H_{RT} + H_L + H_{FT} &= 804,400 \text{ B.t.u.} \end{aligned}$$

Total ice requirement:

$$\begin{aligned} H_{RT} &= 2,149 \\ H_L &= 2,437 \\ H_{FT} &= 1,000 \\ H_{RT} + H_L + H_{FT} &= 5,586 \text{ lb.} \end{aligned}$$

$$\begin{aligned} \text{Total precooling and transit ice requirement} &= \\ 10,465 + 5,586 &= 16,051 \text{ lb.} \end{aligned}$$

Under the conditions assumed, re-icing the car to capacity at loading point after precooling and shipping without re-icing in transit should be more than ample refrigeration to maintain a temperature of 50° F. to destination.

## 3. Nonprecooled load, cooled in transit:

Assumptions:

Same load and temperatures as in paragraphs 1 and 2.

Time to cool in transit = 3 days (72 hr.)

Av. outside temp. = 75°

Transit time = 5 days (120 hr.)

Field heat: 1,329,600 B.t.u. (same as in paragraph 1 for precooling).

Ice requirement: 9,233 lb.

Car body heat: 105,600 B.t.u. (same as in paragraph 1 for precooling).

Ice requirement: 733 lb.

$$\text{Heat of respiration } (H_R) = \text{Respiration rate} \times \text{days} \times \text{Wt. (tons)}$$

$$\text{Av. temp. during 3 days cooling} = 65^\circ$$

$$\text{Av. respiration rate at } 65^\circ = 4,000 \text{ B.t.u./ton/day}$$

Av. temp. during remaining 2 days in transit =  $50^{\circ}$

Av. respiration rate at  $50^{\circ}$  = 2,600 B.t.u./ton/day

$H_R$  (3 days cooling) =  $4,000 \times 3 \times 23.8 = 285,600$  B.t.u.

$H_R$  (last 2 days) =  $2,600 \times 2 \times 23.8 = 123,760$  B.t.u.

Total heat of respiration:  $285,600 + 123,760 = 409,360$  B.t.u.

Ice requirement: 2,843 lb.

Heat leakage ( $H_L$ ) = Conductance  $\times$  TD  $\times$  hours

Av. TD during 3 days at  $65^{\circ} = 10^{\circ}$

$$H_L = 117 \times 10 \times 72 = 84,240 \text{ B.t.u.}$$

Av. TD during 2 days at  $50^{\circ} = 25^{\circ}$

$$H_L = 117 \times 25 \times 48 = 140,400 \text{ B.t.u.}$$

Total heat leakage:  $84,240 + 140,400 = 224,640$  B.t.u.

Ice requirement: 1,560 lb.

Fan heat ( $H_F$ ) = 2,000  $\times$  hr. in transit  $\times$  % car fan operation

$$= 2,000 \times 120 \times .60$$

$$= 144,000 \text{ B.t.u.}$$

Ice requirement: 1,000 lb.

Total transit refrigeration load:

$$H_S = 1,329,600 \text{ B.t.u.}$$

$$H_C = 105,600$$

$$H_R = 409,360$$

$$H_L = 224,640$$

$$H_F = 114,000$$

$$H_S + H_C + H_R$$

$$+ H_L + H_F = 2,213,200 \text{ B.t.u.}$$

Total ice requirement:  $9,233 + 733 + 2,843 + 1,560 + 1,000 = 15,369$  lb.

Following is a comparison of refrigeration requirements of the precooled and nonprecooled cars:

Heat load	Precooled car (lb. ice)	Nonprecooled car (lb. ice)
Field heat -----	9,233	9,233
Heat of respiration -----	2,370	2,843
Car body heat -----	733	733
Heat leakage -----	2,437	1,560
Car fans -----	1,278	1,000
Total -----	16,051	15,369
	lb. (8.03 tons)	lb. (7.68 tons)

These calculated totals indicate a slightly greater ice requirement for the car precooled before moving in transit. This is due to the increased heat leakage in the precooled car because of a greater temperature difference between the inside and outside of the car for the entire period of 5 days.

These calculations are presented only to give the reader some understanding of refrigeration requirements and some of the factors which contribute to ice meltage. The mechanical re-

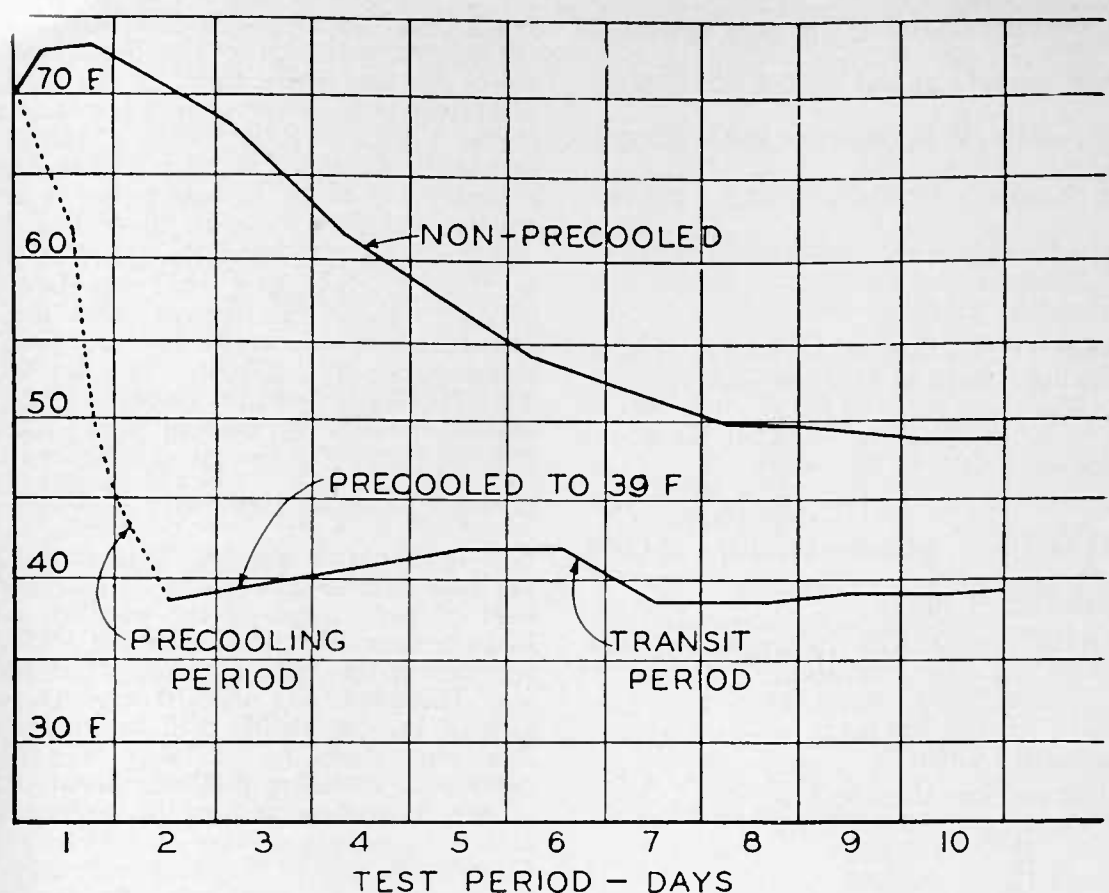
frigeration capacity required can readily be calculated by dividing the heat load in the above problem by the time. In the example, the total heat to be removed in 8 hours of precooling is 1,506,997 B.t.u. This is 188,375 B.t.u. per hour. Dividing this by 12,000 shows that a capacity of about 15 tons would be needed at the temperatures stated in the problem.

A question that has been asked many times is, "How much cooling can I expect from a ton of ice?" Using the figures from the sample calculation, this is simple to determine. In the equation  $H = \text{Wt.} \times \text{Sp.ht.} \times \text{TD}$ , we find that  $\text{TD} = H / (\text{Wt.} \times \text{Sp.ht.})$ . The amount of refrigeration available for cooling from 1 ton of ice is 288,000 B.t.u. For the given load then the temperature reduction expected =  $\frac{288,000}{1056 \times 45 \times .90} =$

6.73 or roughly 7 degrees. This, of course, does not take into consideration the car body heat, heat of respiration of the product, and heat leakage from the outside which will compete for the refrigeration available from the ton of ice. Therefore, the actual temperature reduction of the commodity will be somewhat less. Precooling tests on carloads of grapes and cantaloups indicated that only about 70 percent of the theoretical amount of cooling could be attained, because of loss of refrigeration. As the sensible heat of the fruit represents around 90 percent of the total heat, it is reasonable to assume that the actual temperature reduction will be about 90 percent of 6.73 or 6 degrees, if no losses occur. Products with a lower specific heat such as sweet corn (0.79) have a lower heat content so that a little more cooling could be expected. As a rule of thumb then, we can say that 1 ton of ice, under conditions of no refrigeration loss, will cool 24 tons of fruit 6 degrees. It should be remembered that time is not involved in this calculation. The time required to do this cooling will depend on the method of precooling used.

## Precooling Methods

Precooling is the rapid cooling of a commodity to a suitable transit or storage temperature soon after harvest, before it is stored or moved in transit. Precooling is accomplished before or after packaging; by holding in storage, special cooling rooms, or tunnels before loading or by cooling in the car after loading. Types of precooling include hydrocooling, vacuum cooling, room cooling, tunnel cooling, cooling in car with mechanical device, or the use of package and top ice (98, 99). Adequate precooling reduces the transit refrigeration requirements and helps to maintain more uniform temperatures (fig. 23).



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FIGURE 23.—Adequate precooling results in lower transit temperatures. Two cars of warm pears shipped under Standard Refrigeration Service (one precooled in car, the other nonprecooled) and scheduled for storage at terminal market.

*Hydrocooling* is accomplished by flooding, spraying, or submerging the commodity in cold water (fig. 24). Refrigeration is supplied by means of ice or mechanical refrigeration. Usually the product is packed in conventional wooden containers before hydrocooling and the containers are lidded after passage through the hydrocooler. The increasing use of fiberboard boxes or cartons has resulted in considerable research to develop a waterproof fiberboard that will stand up during hydrocooling and in transit after wetting. Bulk hydrocooling (before packaging) of certain commodities is now being done in several States. The time required to obtain the desired temperature in a hydrocooler depends on the physical characteristics of the commodity, the amount of heat to be removed, the type of container, and the volume, velocity, and temperature of the water (129).

Water temperature should be kept as close to 32° F. as possible for maximum cooling rate. The performance of the hydrocooler should be watched closely by frequent checks on fruit

temperature. The water can be kept sanitary by the use of bactericides which are made available by the manufacturers. Research on the use of fungicides in the cooling water is being carried on; some fungicides are being used in citrus hydrocooling.

*Vacuum cooling*, a relatively new method of rapid cooling, is particularly adapted to the leafy vegetable (26). Celery and sweet corn are also being cooled by this process although more time is usually required than for leafy products such as lettuce or spinach. The rapid cooling obtained with vacuum and the elimination of package and top ice has resulted in the wide adoption of fiberboard cartons for certain products, notably lettuce.

Vacuum cooling is based on a simple principle. The commodity to be cooled is placed in a steel chamber or tube that can be tightly sealed (fig. 25) and a high vacuum is drawn. Water evaporates rapidly from the commodity under these conditions provided the resulting vapor is condensed or exhausted from the system. The commodity is cooled by this evaporation at

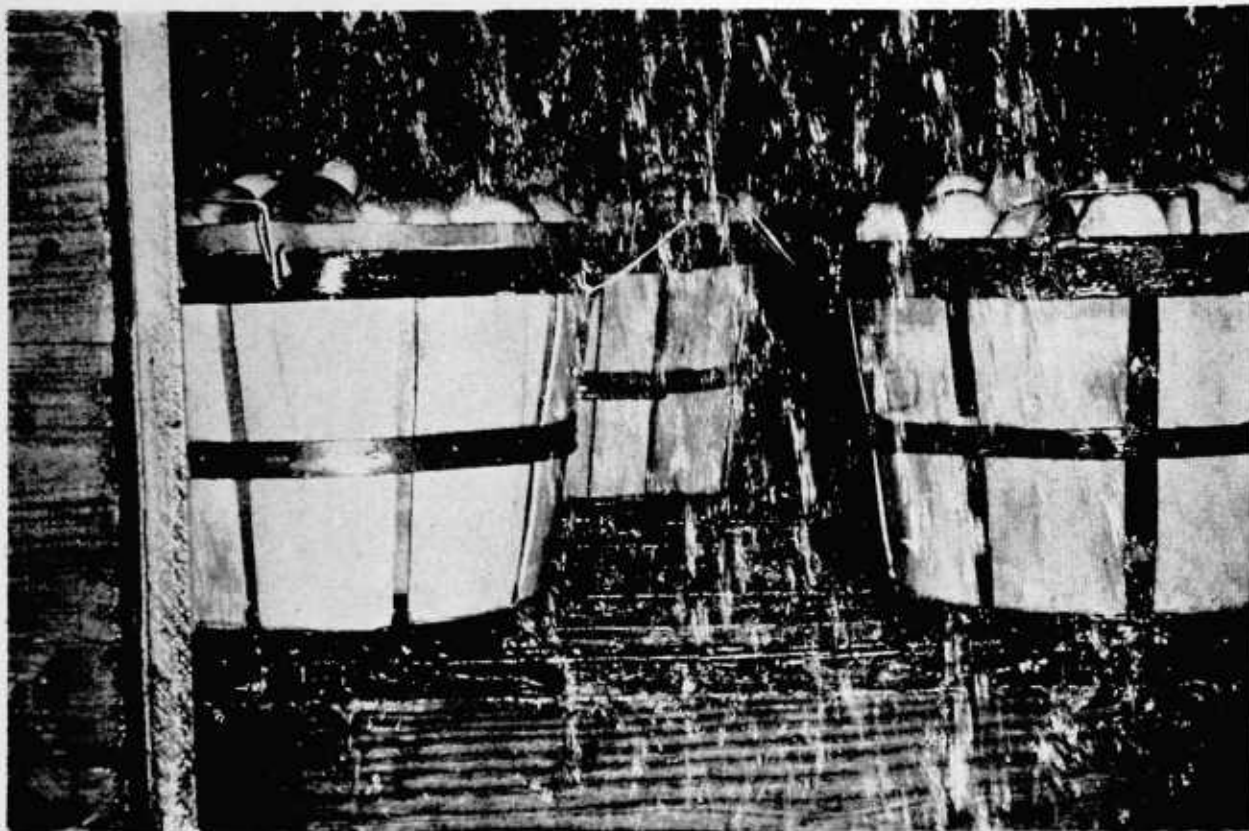


FIGURE 24.—Packed peaches moving through hydrocooler.

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a rate of around 1,060 B.t.u. removed per pound of water lost. Since the boiling point of water drops under reduced pressure, the pressure in the tubes is held close to 4.6 mm. or .18 inch of Hg. At this point water boils at 32° F.; thus a high rate of cooling is accomplished without danger of freezing the commodity.

The rate of cooling under vacuum depends upon the ratio of surface to volume or mass of the commodity and the ease with which water can be removed from the tissues. Thus leafy vegetables cool much faster and to a lower temperature in practice than, for example, cantaloups or potatoes. While this process necessarily removes some water from the product, the moisture loss is not high enough to impair quality in the commodities now being commercially vacuum cooled. Cooling is continued to the desired temperature by further reducing the air pressure. Evacuation of the chamber and cooling of the product require about 30 minutes for leafy vegetables. One of the advantages of the vacuum process is that cooling proceeds uniformly throughout the produce in standard containers and conventional load patterns. Studies have shown that impermeable materials, such as film liners in lettuce cartons, greatly reduce the cooling rate.

The film must be perforated to allow moisture to be removed from the container. The use of vacuum cooling and fiberboard cartons has made field packing possible with some commodities, thereby reducing costs as compared with former shed operations. Because of the high initial and operating costs and the complexity of the equipment, permanent vacuum installations are limited to large-volume business in central locations. However, practical portable vacuum cooling units have been developed, which have extended use of the process to many areas of limited production (99).

*Room cooling* probably provides the most thorough precooling where refrigeration facilities are available in the packing area (120). Disadvantages are the slow cooling rate and the extra handling involved. However, it provides for the accumulation of wanted sizes and grades of commodities and permits holding them for market for short periods if necessary. Refrigeration is supplied by mechanical units or by ice bunkers. Rapid cooling is dependent on adequate volume and velocity of air, as provided by portable or built-in fans. Containers must be stacked properly to permit maximum air flow around or through them for rapid cooling (120). Cars can generally be loaded



FIGURE 25.—Carload of lettuce moving into vacuum cooler.

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more advantageously from a precooling room than from the packing line. Gases for decay control may be applied in storage and cooling rooms if means are provided for exhausting or washing the gas from the air after each exposure period.

A new method of room cooling now being tried with fruit is forced-air cooling. The containers are tightly stacked in rows to prevent air passing between the containers. The air is forced through the fruit because a pressure differential is developed between the two sides of the containers. Very favorable cooling rates have been obtained by this method in California with packs and containers which permit free passage of air (32, 33, 34). It has also been tried in car cooling with some success.

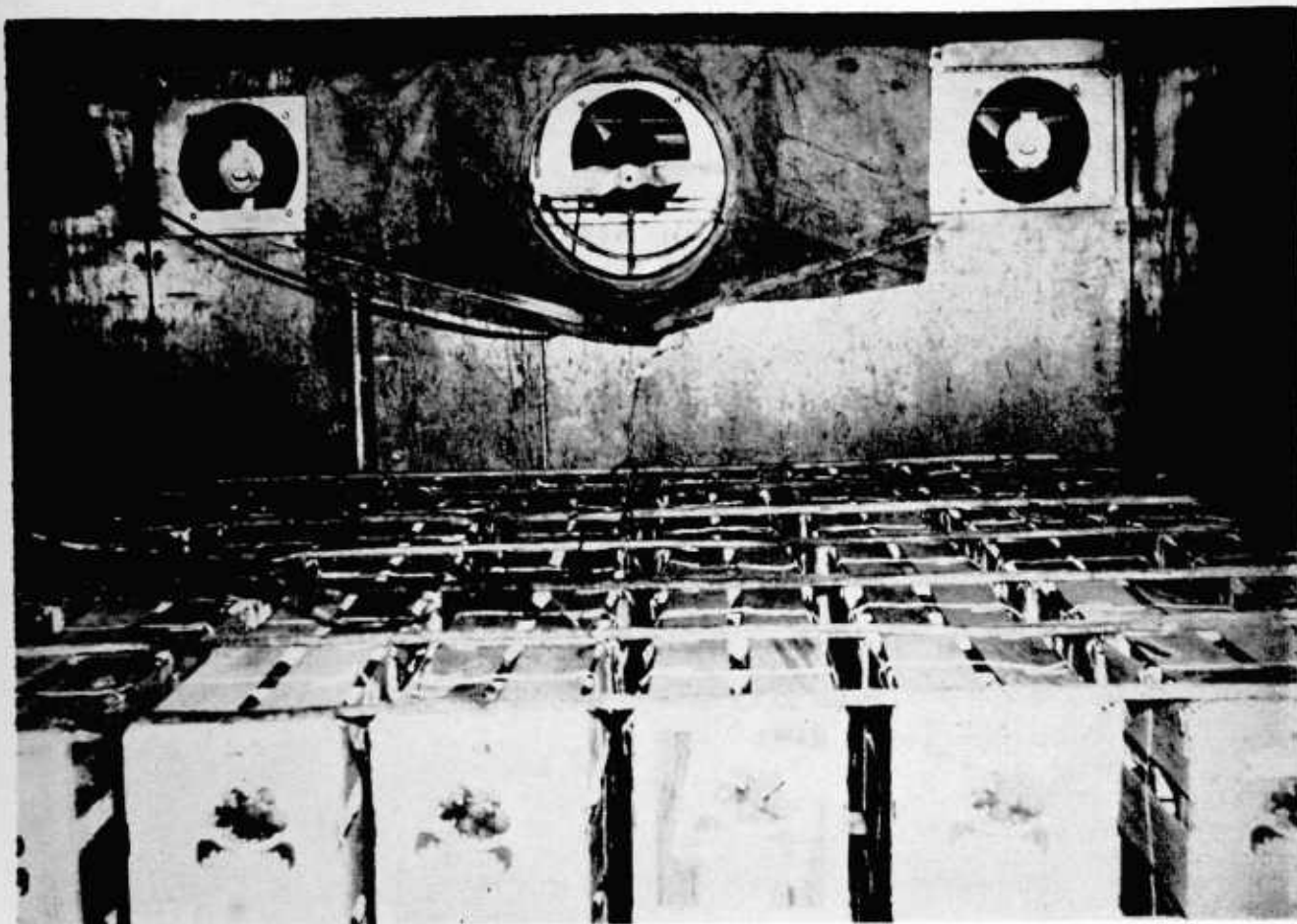
Tunnel coolers in which produce is moved beneath high-velocity jets of cold air are used to a limited extent in California. The produce may move directly from the tunnel into cars or it may be placed in storage rooms for holding or further cooling. This method requires a number of high-speed fans which use considerable power (81).

*Car precooling*, or cooling in the car after the warm commodity has been loaded, is ac-

complished through (1) utilizing the bunker ice by operating either car fans or portable precooling fans, or both, (2) using mechanical precooling units mounted along the tracks or on trucks, (3) using top ice on the load with or without package ice, and (4) circulating cold air from a storage-plant cooling system into the car.

Car fans are operated by portable precooling motors (electric or internal combustion) attached to special fittings on the car as shown in figure 4 (103). Portable precooling fans are mounted at the top bunker openings in both nonfan and floor-fan cars, or over the center fan in electric fan cars. To increase cooling rates the car fans and portable fans can be operated simultaneously (fig. 26) (100). In electric fan cars the canvas baffles of the portable fans should not cover the two outside or corner car fans, as a greater volume and movement of air is obtained with these fans uncovered.

In all types of air cooling, high air velocity is necessary, not only to quickly carry the heat from the load to the ice or cooling coils, but to provide good air distribution through the load. Because of the great refrigerating capacity of



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FIGURE 26.—Recommended method of installing portable precooling fans for operation in conjunction with electric car fans. Corner car fans should be left uncovered.

ice, especially with air movement over its surfaces, the cooling rate is determined largely by the velocity and distribution of the air. With the use of fiberboard cartons there has been considerable difficulty in precooling because of the usual solid load pattern, inadequate ventilation of the cartons, and the natural insulating characteristics of the fiberboard which reduces heat flow from the product. Many studies are being conducted to develop adequate ventilation in fiberboard cartons and improved load patterns that will permit better air circulation to all containers in the load (41, 142). As the rate of cooling depends largely on the amount of surface of the carton exposed to air movement, it is important to open the load as much as possible. A step in this direction is the chimney method of loading (fig. 27). However, this method exposes only a limited surface to air movement and is not as efficient as the bonded block method (fig. 15 on page 28).

Cars should be pre-iced when used for precooling, as much of the heat stored in the car superstructure will thus be removed, and some

cooling of the product will occur during loading. It is desirable that the ice bunkers be replenished to capacity before the precooling fans are started. In pre-iced cars the old ice should be barred down before replenishing and all voids eliminated so that the maximum amount of ice can be placed in the bunkers. For most commodities, it is necessary to add salt to the ice before the start of precooling. At least 400 pounds per car should be supplied during the re-icing and worked in well with the ice. Additional salt should be added during the precooling of warm loads. The ice should not be allowed to become lower than the half-way level in the bunkers during precooling and the bunkers should be refilled to capacity before the car is released for transit, or the car should be re-iced at the first icing station if it is close to the loading point. The shipper or precooling operator should take temperatures of the commodity in a number of places in the car with accurate insert thermometers, to determine what amount of cooling was done. A single temperature taken in a container at the door-

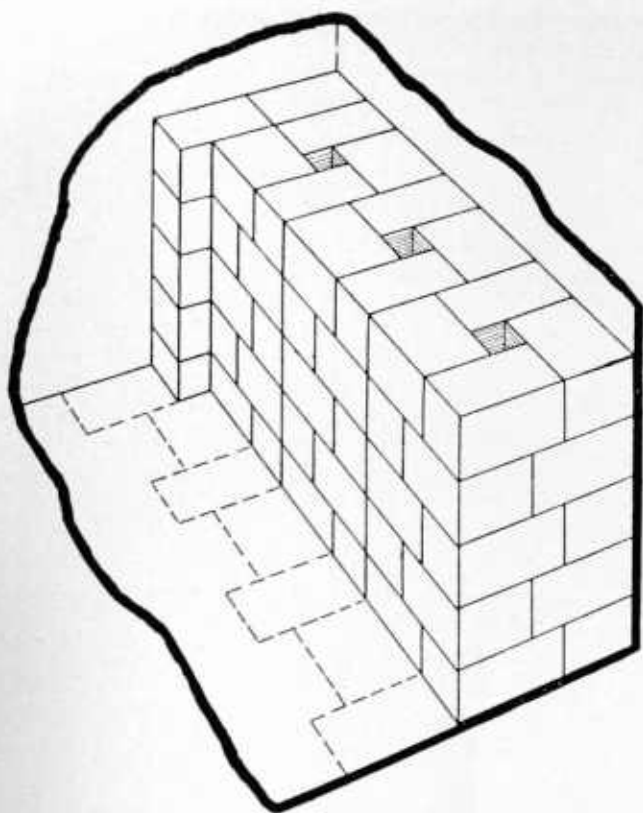


FIGURE 27.—One manner of providing openings in a carton load (chimney method). However, note the small areas of carton surfaces exposed to the circulating air in the chimneys.

way will not represent the average load temperature.

In many cases, not enough time is allowed for thorough precooling due to lateness in loading, early pickup by the railroad, and the desire to get a car rolling to market as soon as possible. Thorough precooling will provide lower average transit temperature and better product condition at destination.

Many of the above suggestions apply to mechanical precooling units as well. It is important to pre-ice the cars, to provide an open load pattern for maximum contact of cold air with the commodity, and, above all, to allow sufficient time for precooling. Truck-mounted precooling units (fig. 28) may be used in certain areas where electric power is not available to operate car and portable fans. This is true when limited track space is available at the loading shed and loaded cars must be moved away to provide space for incoming empty cars. Precooling unit operators should keep a close check on air blast and return air temperatures and promptly defrost the cooling coils when required. Care must also be taken in adjusting the canvas baffle placed on top of the load at the doorway, so that the cooling air does not bypass



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FIGURE 28.—Precooling car with truck-mounted, mechanical refrigerating unit.

or short circuit other parts of the load. The bunker top openings and car fan openings should be covered to prevent the air from bypassing the load.

Warm produce loaded in a mechanical car is cooled by the car's refrigeration unit. It is not necessary to hold mechanical cars at the loading station for precooling as required when auxiliary precooling equipment is used in regular ice-bunker cars (4). One of the advantages of the mechanical car is that cooling begins immediately after the doors are closed on completion of loading, and continues uninterrupted whether or not the car is moving. However, most of the mechanical cars now in service are designed primarily to maintain desired temperatures in transit, rather than to precool rapidly at origin. The additional capacity and higher air velocities that would be required for rapid cooling of warm loads would increase equipment cost considerably.

Most of the present mechanical equipment will reduce commodity temperature to 40°-50° F. in 18 to 24 hours, which is satisfactory for

many of the less perishable fruits and vegetables. Some mechanical cars have been designed for rapid cooling. More attention is being directed to this factor in the general service cars now being built. The use of stated amounts of body ice in these cars for precooling or as an aid to cooling in transit has been authorized for melons and vegetables in some areas. However, this applies only to the relatively few mechanical cars equipped with floor racks and suitable drains for disposal of water from the melting ice.

Crushed ice placed in the container as it is packed is an excellent means of rapid cooling, but with many commodities, it is being supplanted to a large extent by hydrocooling and vacuum cooling. Snow ice, blown into the car to cover the top of the load and fill channels in the load, is also effective in precooling leafy vegetables, cantaloups, and similar perishable products (72). The water from the melting ice moves down through the load and maintains the desirable high humidity. For precooling some fruits and vegetables, cantaloups for instance, portable precooling fans or car fans are used to accelerate meltage of the ice and cool the load before transit movement (83). By melting all of the top ice before transit, the shipper is relieved from the payment of certain charges ordinarily assessed by the railroads on cars which are forwarded with ice remaining on the load.

Some western railroads have established precooling plants for rapid cooling of loaded cars at certain origin points. This service is fur-

nished to citrus shippers for about \$8 per car. The cars are moved to these plants from the loading stations and cold air is forced through the cars by the use of ducts connected to the bunker hatch openings.

### Transit Refrigeration

The refrigeration service required in transit depends on (1) commodity characteristics, (2) seasonal temperatures, (3) load temperature (whether precooled or not), (4) load pattern, (5) type of container, (6) routing, and (7) destination. Basically, the commodity will dictate the overall transit environment required. These may be grouped as follows: minimum refrigeration ( $50^{\circ}$  to  $65^{\circ}$  F., for such items as bananas, lemons, mature-green tomatoes); average refrigeration ( $38^{\circ}$  to  $50^{\circ}$ , for oranges, peaches, grapefruit); maximum refrigeration ( $32^{\circ}$  to  $37^{\circ}$ , for sweet corn, strawberries, grapes, asparagus, cherries); frozen foods ( $0^{\circ}$  and below).

Outside air temperatures en route are a primary influence on inside car temperatures in transit. The refrigeration service must be adjusted to seasonal variations. If a load has been thoroughly precooled either before or after loading, less refrigeration in transit is necessary to maintain desired temperatures. Refrigeration costs may be reduced by the use of such services as half-stage (fig. 29) or modified icing services in fan cars (described in following sections). Moderately warm loads moving in fan cars may be cooled in transit nearly as

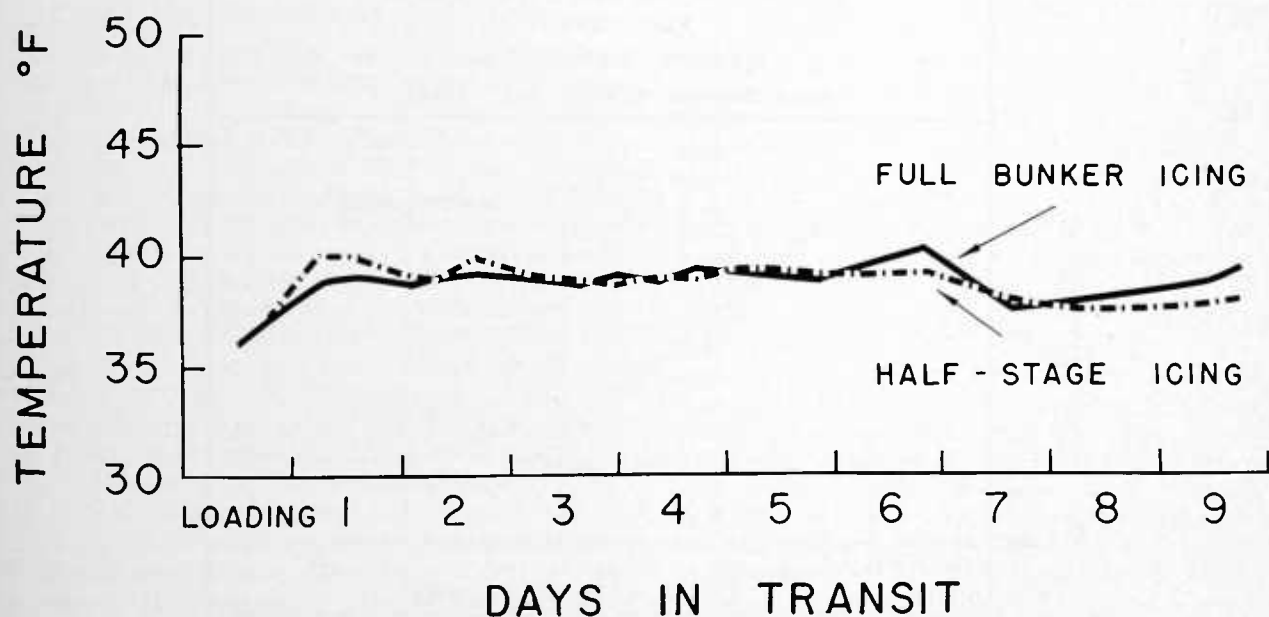


FIGURE 29.—Transit temperatures of room-precooled California grapes shipped in fan cars under full bunker and half-stage Standard Refrigeration Service.

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effectively with half-stage as with full bunker refrigeration as shown in figure 30. Shipments moving to northern destinations over relatively cool routes will require less refrigeration than those going to warmer southern areas.

The means for obtaining specific transit temperatures are provided under the regulations of the Perishable Protective Tariff. These include such varied refrigeration services as certain amounts of ice specified by the shipper; initial ice with no re-icing in transit; initial ice plus one, two, or three re-icings; or Standard Refrigeration Service in which the bunkers are re-iced to capacity about once a day en route. Varying amounts of salt may be added if desired in very hot weather; also different quantities of top ice may be placed on the load, with or without bunker ice. The icing services recommended for fruits and vegetables are presented in detail in tables 7, 8, and 9.

It is important that full advantage be taken of the protective services provided in the Perishable Protective Tariff, not only for proper protection of the commodity but to reduce the cost of the service. Overrefrigeration may not only damage the lading but result in unnecessary costs to the shipper. In certain instances, a railroad may offer a quantity of free ice for a certain commodity at a specified time of the year. The shipper should keep informed of such offers by contact with his local

railroad representative or by means of trade publications. It is again emphasized that car fans should always be placed in the "ON" position regardless of the protective service used, in order to obtain uniform temperatures and faster cooling.

In mechanical cars, temperature is controlled by the thermostat setting. Suggested temperatures for various commodities shipped in these cars may be found in table 4, page 25.

## Ventilation

Many times during the year the temperature of the outside air is below that desired for the commodity. Within certain limitations, outside air may then be used to cool the load by opening the ventilators of refrigerator cars and circulating the cool air through the load. The amount of cooling desired is obtained by manipulating the vents at different outside air temperatures and at certain regularly assigned inspection points as specified by the shipper (fig. 31). Commodities may not only be cooled or warmed, but some that are washed just before loading, such as potatoes, may have much of the surplus moisture removed in transit by proper venting. No charge is made by the carriers for this service but the waybills must carry full instructions as authorized in the Protective Tariff from the shipper covering the class of ventilation desired.

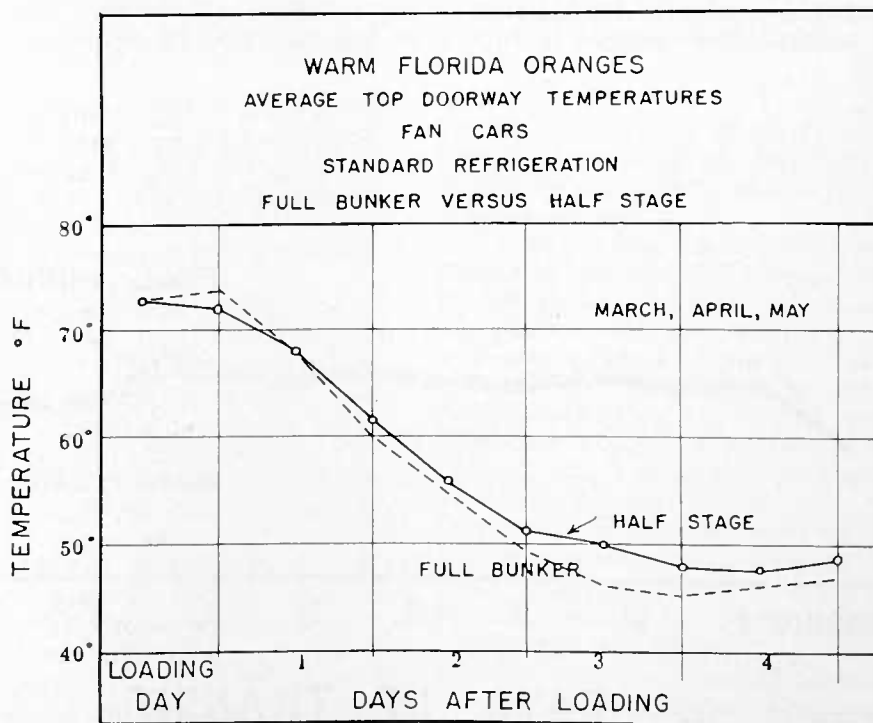
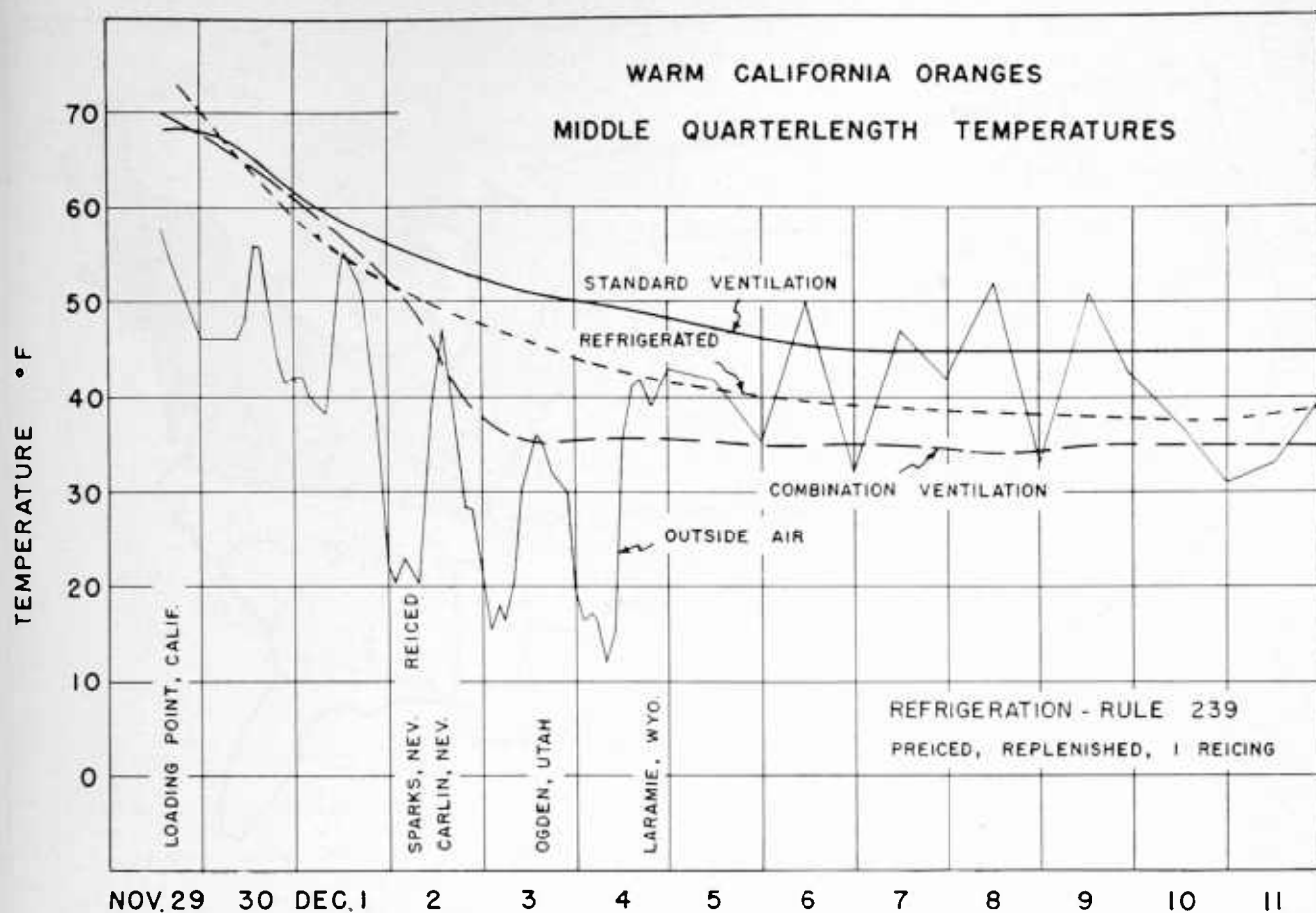


FIGURE 30.—Transit temperatures of warm Florida oranges shipped under full bunker and half-stage Standard Refrigeration Service.

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AMS Neg. 8156-60(10)

FIGURE 31.—Transit cooling of citrus obtained by leaving car vents open to 20 F. under Combination Ventilation, compared with Standard Ventilation or refrigeration.

### Protective Service Against Cold

During winter months, cars moving through low outside temperatures may be heated to prevent losses from freezing. The railroads provide heater service with portable heaters under the Perishable Protective Tariff in "Heater Territories" designated therein (figs. 32 and 33), which cover roughly the northern half of the United States (51, 55). The service is available for shipments originating in or moving into or through these territories during specified winter months. It is optional on the part of the shipper with the exception of potatoes (other than sweetpotatoes or yams) for which Carriers' Protective Service is compulsory from November 16 through February in Heater Territory, part 1. There is also a Voluntary Heater Service provided by the carriers at stations in Heater Territory, part 1, at stations outside of the Heater Territory west of the Mississippi River, and at some stations east of the river on a few specified railroads. This heater service, however, applies only to fruits

and vegetables originating at stations outside of Heater Territory, Part 1.

An apparent lack of knowledge on the part of some shippers of the need for and the availability of heater service, together with the shipper's desire to keep transportation costs as low as possible, results in heavy losses from freezing damage each year. Losses are greatest in commodities that are normally moved at temperatures near their freezing point, such as lettuce, celery, and particularly apples when shipped out of cold storage (71). The approximate freezing points of certain fresh fruits and vegetables are shown in table 3, page 24. Shipments of top-iced vegetables have been particularly vulnerable, especially when moving with additional ice in the bunkers. Cars from the warm producing areas often move into northern regions where the temperatures may be well below zero before heater service can be inaugurated. It is costly to remove ice from the bunkers for installation of heaters. Also, undesirable temperature changes may occur in the car during the operation. Therefore, bunker

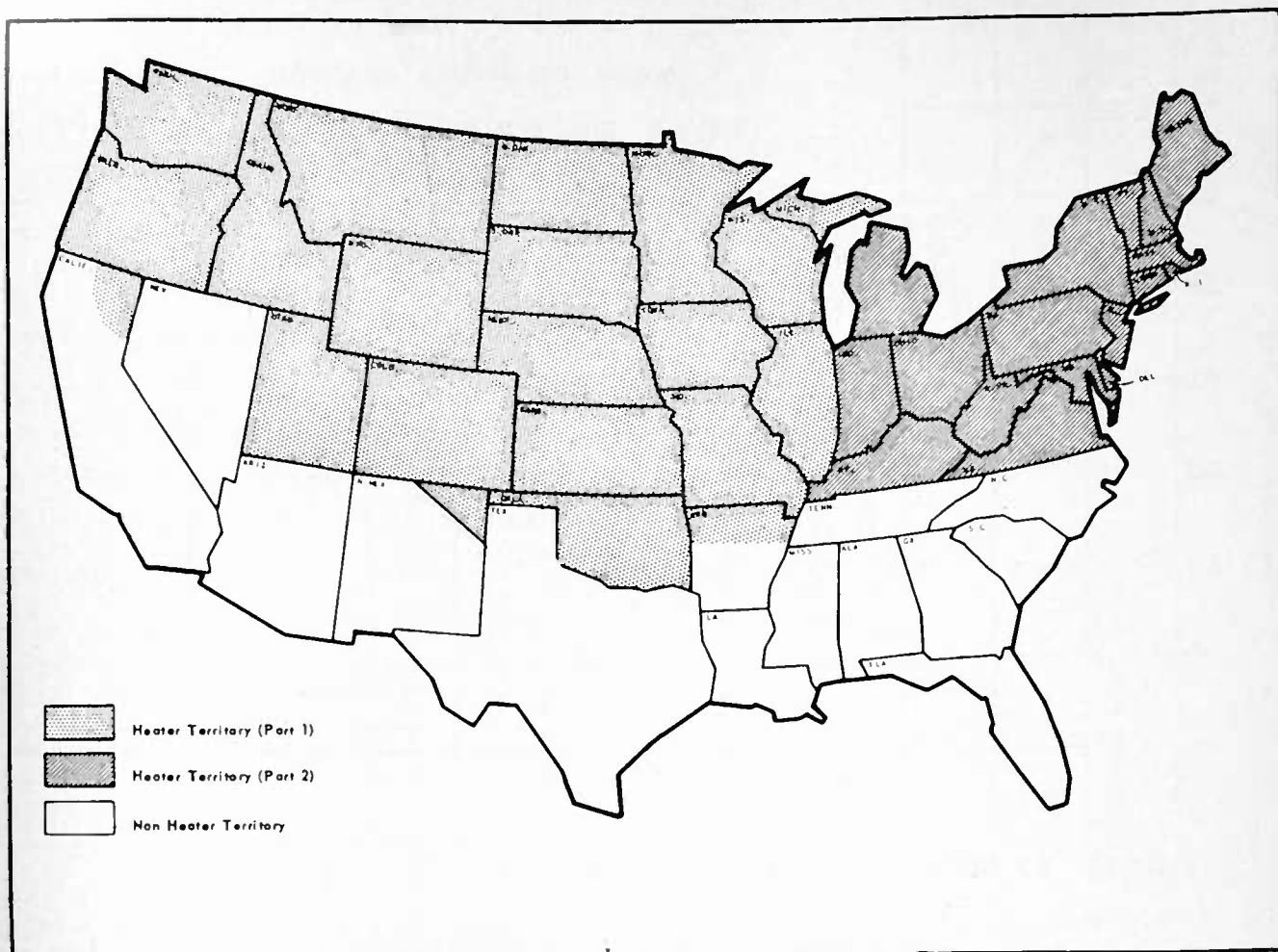


FIGURE 32.—Heater Territory (Parts 1 and 2).

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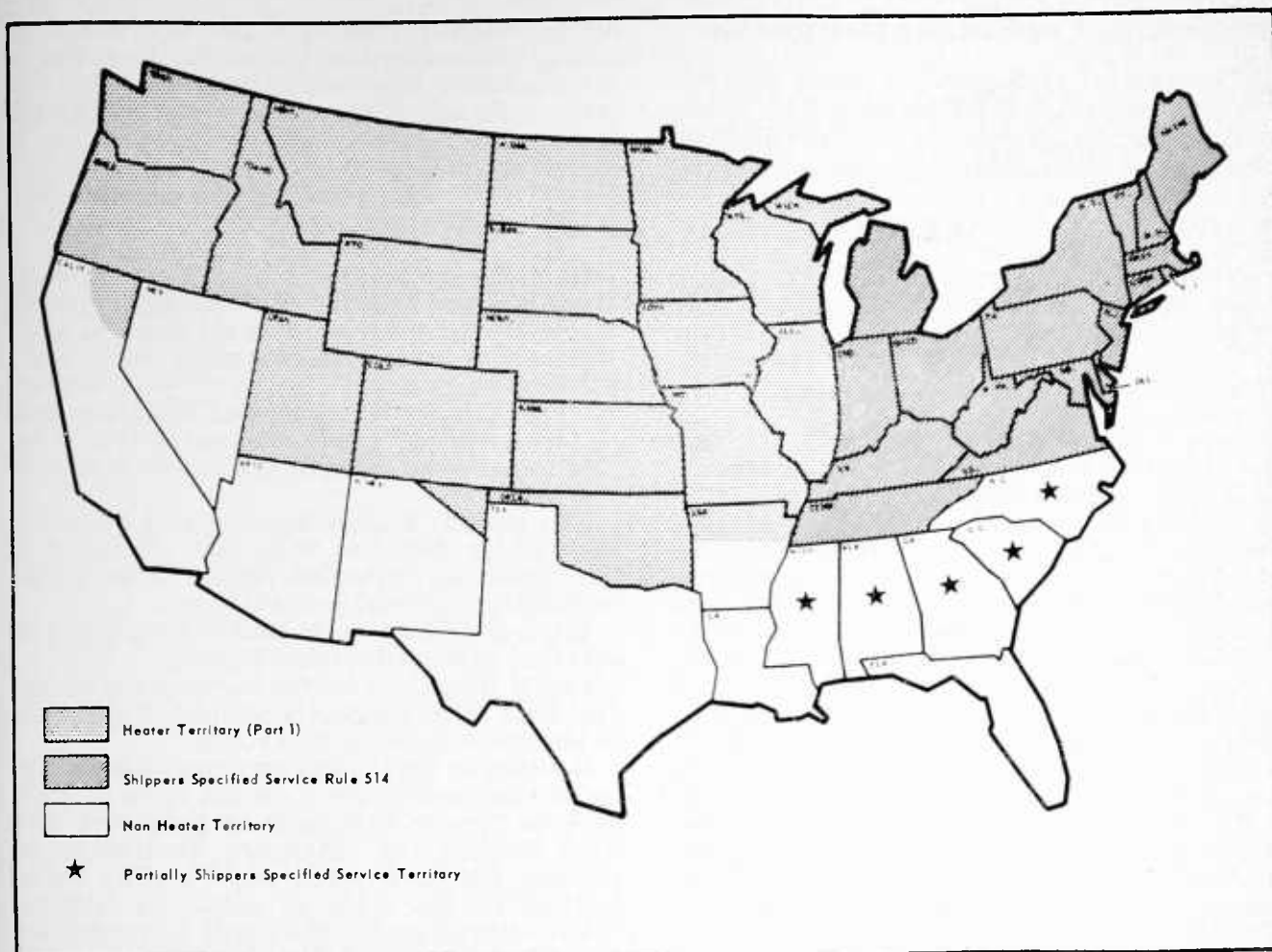
ice service should be prescribed only if necessary.

Serious consideration should be given by the shipper or receiver to ordering a heater service for shipments moving into the Heater Territory before very low temperatures are encountered in transit. Heater service may be advisable for certain commodities for which it has not been specified in the tables of recommended protective services which follow. Existing and anticipated weather conditions upon which to base this decision are usually available from the local offices of the Weather Bureau. Full advantage should be taken of this valuable service.

Heater service, in general, as defined by the tariff, not only provides protection against freezing, but also against artificial overheating. When portable charcoal heaters, with uncontrolled burning rate, were used in nonfan cars, there was constant danger that high temperatures would be built up in the top layers of the load and would result in overripening or other

adverse effects. Thermostatically controlled liquid fuel (LF) heaters (fig. 6), with control based on inside air temperatures, in fan-equipped cars provide safe and uniform temperatures. These heaters are also of considerable advantage in nonfan cars because their thermostatic control reduces the danger of overheating in the top layers of the load. Automatic LF heaters are rapidly replacing manually controlled charcoal heaters, especially in Heater Territory, part 1. The lighting and extinguishing of heaters at specific outside air temperatures may eventually become obsolete for most commodities (104, 105). Protection against freezing in most general-service mechanical cars is provided thermostatically either by electric heating elements or by hot gas in the refrigerating unit under reverse cycle operation (4).

A number of heater services are available to the shipper. They vary in cost and completeness of coverage, and their use will be governed by the geographical location of shipping point



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FIGURE 33.—Heater Territory (Part 1) and Shippers' Specified Service Territory.

and routing of the car. The most complete coverage is Carriers' Protective Service in which the railroad assumes all responsibility for freezing damage. In Shippers' Specified Service, available generally in the eastern half of the country, the heating equipment and service is furnished by the carrier, but temperatures for lighting and extinguishing (or thermostat setting on LF heaters) are specified by the shipper. Under Shippers' Protective Service, the shipper or his agent may supply all heaters and initial servicing thereof, but subsequent servicing is by the carrier as the shipper directs (101).

With all these classes of service, the shipper must specify the type of ventilation desired. It may range from Standard Ventilation to "Keep Vents Closed."

Heater services are covered in more detail in the section pertaining to the tariff rules.

Cars moving to destinations in Canada may have heater service provided by the Canadian

railroads on a basis somewhat similar to that in the United States. If heater service in Canada or definite ventilation instructions are not specified by the shipper on the waybill, shipments will be handled under Standard Ventilation after crossing the border. At the present time only charcoal portable heaters are used for the most part in end bunker cars in Canada. LF heaters are not generally available. Except under special arrangements U.S.-owned heaters are removed at the border and Canadian heaters installed. Under "Standard Heating in Canada," the portable charcoal heaters are lighted and extinguished by the Canadian railroads at specified outside temperatures for different kinds of commodities (15). These temperatures are also shown in the regular Perishable Protective Tariff of the U.S. railroads. However, the shipper is permitted to specify other lighting and extinguishing temperatures on the bill of lading if he wishes.

## Operating Car Fans at Destination

Upon arrival at destination, many cars are held up to several days before unloading. While under refrigeration with the car fans off, temperatures in top layers of a load may rise

several degrees, causing excessive ripening or decay, whereas bottom layers may be cooled to a dangerously low temperature. Electric holding motors are now available for operating the car fans to maintain a uniform temperature in the car during the holdover period (69).

## RECOMMENDED PROTECTIVE SERVICES

Tables 7, 8, and 9 present the protective services recommended for carlot shipments of the different commodities shown, together with the Perishable Protective Tariff rule numbers applying thereto.

Mixed shipments of certain fruits and vegetables are provided under the tariff. As only one protective service applies to the entire carload, only commodities requiring somewhat similar transit temperatures should be loaded together. In general, the protective service selected should be based on the most perishable commodity in the load. Charges for the protective service on mixed loads are based on the highest rated perishable commodity in the car.

Proper selection of the service to be used must be governed by weather prevailing at loading and anticipated en route, time in transit, kind of container, load pattern, and size of load. Also to be considered are commodity loading temperatures, whether the car will be precooled, condition and maturity of the commodity, and type of car being loaded. These and many other factors must be evaluated by the shipper. To many experienced operators in the produce industry, these requirements are quite familiar. All concerned should be constantly alert to possible savings afforded by modified refrigeration service, but they must keep in mind the temperature requirements of the commodity, the need for more refrigeration to protect certain heavier loads, and the ever-present danger of freezing damage in winter shipments.

Entries in the tables have been kept as brief as possible by including only those factors which may have a direct bearing on the class of protective service to be selected. Descriptions of the protective services recommended have been reduced to a minimum. Usually a choice of services is given, each to provide the desired transit temperature under certain weather conditions or other influencing factors. Some of the services described are not based on studies by the Department but are commercial practices that have been evaluated and given a tentative recommendation. These practices are indicated by a footnote in the tables.

The tariff rule numbers cited are not broken down into parts, sections, or paragraphs thereof. When such additional designation is necessary for entry on the bill of lading, it will be

shown thereon by the carriers' agent at point of origin. The rule numbers appear in numerical order and therefore are not necessarily in the order in which the protective services are listed. The "Remarks" columns of the tables contain such entries as type of container, load pattern, weather conditions, or certain other data to aid in selection of the proper protective service.

The general terminology used in the handbook tables conforms with that appearing in the Perishable Protective Tariffs. A few of the technical terms used are as follows:

**Pre-iced:** Bunkers or tanks of refrigerator cars iced to capacity before loading.

**Initial icing:** To ice the car bunkers for the first time after loading is completed, generally at the first icing station en route.

**Re-icing or ventilation service** at some designated station or after a certain lapse of time, such as "re-ice in transit at third and fifth icing stations" or "Standard Ventilation beginning fourth or fifth night": The actual location of the icing or inspection stations where such special service will be performed, for entry on bill of lading, can be determined by the local freight agent on the basis of the particular train schedule involved.

**Percentage of salt (2% salt, etc.):** The ratio of salt to be added should be based on the quantity of ice supplied.

**Icing:** All icing or re-icing operations referred to pertain to full-bunker icing unless "half-stage" icing or stated amounts of ice are specified.

**Cold storage:** Refers to commodities that have been held in a cold room at or near the desired transit temperature for some time before loading.

**Room precooled:** Commodity is cooled to near the desired transit temperature by placing in cold room for a short time, generally overnight or from 8 to 12 hours.

**Precooled in car:** Referred to in the tariff as "cooling in car." Car fans, portable fans, or mechanical cooling units are used.

**Carton:** A "fiberboard box" as defined in the Freight Container Tariffs.

**Shipping point:** The area shown is that which is usually quoted by the produce trade.

**Destination:** "East" means the area generally east of the Mississippi River and north of

Potomac Yard. "North" refers generally to the States along the Canadian boundary between the Rockies and Lake Michigan. "Midwest" is the general area adjacent to the Mississippi River and extending to the Rockies. "West Coast" means the Pacific Coast States, whereas "Northwest" may mean either the Pacific Northwest or such States as Montana, Idaho, or Nevada. "South" or "Southeast" refers to the southern group of States. "Northeast" refers to the New England States, and "South-

west" to the general area of Texas, New Mexico, and Arizona.

These terms are fairly broad in scope and some overlapping can be expected.

References in the handbook to tariff rules are meant to include supplements to and reissues of the tariff, also reissues, changes, and cancellations of such rules, or the items, notes, and exceptions pertaining thereto. The handbook will be revised as often as practicable, to reflect such changes.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Apples-----	Idaho, Oregon, and Washington (all points).	Early fall-----	All points-----	Not precooled----	<i>For immediate consumption:</i> 1. Standard Ventilation or Special Ventilation, Keep vents closed below 32° and above 45°; keep vents open 32° to 45°; or 3. Initial ice, do not re-ice <i>For storage:</i> 1. Standard Refrigeration; or 2. Initial ice, 1, 2, or 3 re-icings in transit; or 3. Initial ice, do not re-ice.	240, 385	Protective service dependent on weather, distance, and ripeness of fruit.
Do-----	do-----	Late fall-----	East, Midwest--	Cold storage----	Initial ice, 1 or 2 re-icings in transit.	247	
Do-----	do-----	do-----	South-----	do-----	Standard Refrigeration-----	201	
Do-----	do-----	Winter-----	East, Midwest--	do-----	Special Ventilation, keep vents closed, Carriers' Protective Service.	515	
Do-----	do-----	do-----	South-----	do-----	Special Ventilation, keep vents closed, Carriers' Protective Service. On leaving Heater Territory, initial ice, do not re-ice (2 to 3 days transit); or Standard Refrigeration for distant destinations in South.	201, 240, 515	
Do-----	do-----	do-----	West Coast----	do-----	Initial ice, half-stage, 1 re-icing in transit for South Coastal destinations.	247, 255	
Do-----	do-----	Spring-----	All points-----	do-----	Standard Refrigeration-----	201	After no danger of transit freezing.
Apricots-----	Washington (Wenatchee, Yakima).	July and August--	do-----	Precool in cold room overnight to about 32° F.	Pre-ice, Standard Refrigeration, 3% salt on basis of amount of ice supplied at all re-icings.	201, 202	Salt may be varied from 2% to 4% depending on weather and amount of precooling.
Do-----	California (central).	June and July----	All points-----	Room or car cool 35° to 40° F.	Pre-ice, Standard Refrigeration, 2% salt at initial and all re-icings. 800 to 1,000 lbs. wrapped dry ice in brace, 100 lb. broken up in each bunker. <sup>2</sup>	1, 4, 5, 15	Express movement

Avocados	California (southern).	Winter	All points, 5 to 10 days.	Precool in car to 45° F.	1. Pre-ice, replenish, do not re-ice; or 2. Initial ice, 1 or 2 re-icings in transit; or 3. Dry car loading. Initial ice, do not re-ice. In cold weather, Special Heater Protective Service. Set thermostat at 45° on liquid fuel heaters, keep vents closed. Also use this same liquid fuel heater service in Shippers' Specified Service Territory, keep vents closed.	246, 247, 254, 514, 580
Do	do	Summer	All points	Precool in car to 45° F.	Pre-ice, Standard Refrigeration, half-stage.	201, 246, 255
Do	Florida (Dade County).	Summer and fall.	do	Not precooled	1. Initial ice, 1 re-icing in transit; or 2. Initial ice, do not re-ice.	240, 251
Do	do	do	do	Room precool	1. Pre-ice, half-stage, 1 re-icing in transit; or 2. Pre-ice, half-stage, do not re-ice.	240, 251, 255
Cherries	Oregon and Washington (Hood River, Wenatchee, Yakima).	June to August	All points	Precool in cold room overnight to about 32° F.	Pre-ice, Standard Refrigeration, 2 to 3% salt at pre-icing and all re-icings; 800 to 1,000 lb. wrapped dry ice in brace, 100 lb. broken up in each bunker.	1, 4, 15; 201, 202
Do	California (San Joaquin and Santa Clara Valleys).	May and June	All points, 3 to 5 days.	do	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings; 800 to 1,000 lb. wrapped dry ice in brace, 100 lb. broken up in each bunker. <sup>2</sup>	1, 4, 15
Citrus; Grapefruit	Arizona (desert valleys).	Winter	do	Not precooled	Same protective services as for Arizona and California nonprecooled oranges during similar season and for same destinations.	239, 240, 385
Do	California (desert valleys, central, southern).	do	do	do	do	239, 240, 385

See footnotes at end of table.

Dry ice not necessary when cherries are packed in lugs having sealed polyethylene liners. Express or freight movement.

Express movement.

Re-icing dependent on weather.

Do.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do-----	do-----	Summer-----	do-----	Precool in car-----	Same protective services as for Arizona and California pre-cooled oranges during similar season and for same destinations.	201, 245, 246, 255	
Do-----	Central and southern Florida.	Start to December 15.	East, Midwest; transcontinental.	Not pre-cooled-----	Same protective services as for Florida nonpre-cooled oranges during similar period and for same destinations.	201, 240, 251, 252, 255, 385	
Do-----	do-----	Winter-----	East, Midwest, 2 to 3 days.	do-----	do-----	385	
Do-----	do-----	do-----	3 to 7 days-----	do-----	1. Combination Ventilation close vents at 25°, open vents above 25° to a designated point, Standard Ventilation thereafter; or 2. Initial ice, do not re-ice, Standard Ventilation from Waycross or Savannah.	240, 385	
Do-----	do-----	do-----	Transcontinental.	do-----	1. Standard Refrigeration, half-stage; or 2. Initial ice, 1 re-icing in transit two days after loading, Standard Ventilation beginning fourth or fifth night; or 3. Initial ice, do not re-ice, Standard Ventilation beginning third night.	201, 240, 251, 252, 255, 385	
Do-----	do-----	March to June-----	East, Midwest; transcontinental.	do-----	Same protective services as for Florida nonpre-cooled oranges, during similar season and for same destinations.	201, 240, 251, 252, 255, 385	
Do-----	do-----	Start to June-----	do-----	Precool by same methods as for Florida oranges	Same protective services as for Florida pre-cooled oranges, during similar period and for same destinations.	201, 240, 246, 251, 252, 255, 385	
Do-----	Texas (lower Rio Grande Valley)	October to November; March and April	East, 6 days-----	Not pre-cooled-----	Initial ice at loading point, 2 re-icings in transit at second and fourth icing stations. <sup>2</sup>	247	

Do-----	do-----	October to November; March and April.	Midwest, 4 days.	Not precooled-----	Initial ice at loading point, 1 re-icing in transit at second icing station. <sup>2</sup>	247	
Do-----	do-----	do-----	Northwest-----	do-----	Initial ice at loading point, 2 re-icings in transit at second and fourth icing stations, keep vents closed origin to seventh icing station, Standard Ventilation there- after. <sup>2</sup>	247, 385	
Do-----	do-----	November to March.	All points-----	do-----	Initial ice at loading point, 1 re-icing in transit at second regular icing station, keep vents closed origin to fourth icing station, Standard Ven- tilation thereafter. <sup>2</sup>	247, 385	
Do-----	do-----	do-----	do-----	do-----	Standard Ventilation origin to destination. <sup>2</sup>	385	When fruit is loaded during cold periods (50° F. mean).
Do-----	do-----	do-----	do-----	do-----	Initial ice at loading point, do not re-ice, keep vents closed origin to second icing station, Standard Ventila- tion thereafter. <sup>2</sup>	240, 385	If outside tem- peratures under 50° F. are anticipated within 24 hr. after initial icing.
Do-----	do-----	April and May	East, Midwest, Northwest.	do-----	Standard Refrigeration 2-----	201	
Lemons-----	Arizona (Salt River Valley); California (central and southern).	Winter-----	East-----	Storage at 50° to 60° F.	Standard Ventilation-----	385	Most lemon ship- ments move under Standard Ventilation. Some icing service is re- commended when the ship- ments consist of "tree ripers" or "B-Silver" lemons.
Do-----	do-----	do-----	South-----	do-----	1. Standard Ventilation; or 2. Pre-ice, replenish, do not re-ice.	239, 385	
Do-----	California (cen- tral, southern).	Summer-----	4 days-----	do-----	Pre-ice, replenish, do not re- ice.	239	

See footnotes at end of table.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do.	do.	do.	5 to 7 days	do.	Pre-ice, replenish, 1 re-icing in transit on third or fourth day.	239	
Do.	do.	do.	8 to 10 days	do.	1. Pre-ice, replenish, 2 re-icings in transit on third and seventh days; or 2. Pre-ice, Standard Refrigeration, half-stage.	201, 239, 255	Extremely hot weather.
Limes	Florida (southern)	April to January.	All points, 3 to 9 days.	Not precooled	1. Initial ice, do not re-ice; or 2. Standard Refrigeration, half-stage.	201, 240, 255	1. Cool weather. 2. Hot weather and long hauls.
Do.	do.	do.	do.	Room precool 52° to 55° F.	1. Initial ice, half-stage, 1 re-icing in transit; or 2. Initial ice, 1 re-icing in transit.	251, 252, 255	1. Cool weather. 2. Hot weather and long hauls.
Oranges	Arizona and California (all points).	Winter.	East.	Not precooled	1. Combination Ventilation, close vents at 20°, open vents above 20° to a designated point, Standard Ventilation thereafter; or 2. Pre-ice, replenish, do not re-ice; or 3. Initial ice, do not re-ice	239, 240, 385	3. Use only when pre-iced cars not available.
Do.	do.	do.	do.	Precool in car.	Pre-ice, replenish, usually no re-icing in transit.	245, 246	Precool by carrier or shipper.
Do.	do.	Spring and summer.	Up to 4 days.	Precool in car or cold storage.	Pre-ice, replenish, do not re-ice.	245, 246	Do.
Do.	do.	do.	5 to 7 days	do.	Pre-ice, replenish, 1 re-icing in transit on third or fourth day.	245, 246	Do.
Do.	do.	do.	8 to 10 days	do.	Pre-ice, replenish, 2 re-icings in transit on third and seventh days.	245, 246	Do.

Do	do	do	All points	do	Pre-ice, Standard Refrigeration, half-stage.	201, 246, 255	This is one of the most complete and safe services and is highly recommended for all mid-summer shipments.
Do	Florida (all points).	Start to December 15.	East, Midwest, 2 to 3 days.	Not precooled	Combination Ventilation, close vents at 25°, open vents above 25° to a designated point, Standard Ventilation thereafter.	385	
Do	do	do	3 to 4 days	do	Initial ice, 1 re-icing in transit on first or second day. In cold weather, Standard Ventilation beyond Potomac Yard or Cincinnati.	251, 252, 385	
Do	do	do	do	do	Initial ice, 1 re-icing in transit at Potomac Yard. In cold weather, initial ice, do not re-ice, Standard Ventilation beyond Potomac Yard.	240, 251, 252, 385	"Advance schedule" shipments.
Do	do	do	5 to 7 days	do	Standard Refrigeration, half-stage.	201, 255	Early fall; warm weather.
Do	do	do	do	do	Initial ice, 1 re-icing in transit on first or second day. In cold weather, Standard Ventilation beginning third or fourth night.	251, 252, 385	Late fall; cool weather.
Do	do	Start to December 15.	Transcontinental.	Not precooled	Standard Refrigeration, half-stage.	201, 255	
Do	do	do	East, Midwest, 4 to 5 days.	Room precool or precool in car with mobile unit.	1. Initial ice, do not re-ice; or 2. Initial ice, do not re-ice, Standard Ventilation beginning third night.	240, 246, 385	
Do	do	do	do	do	Initial ice, half-stage, 1 re-icing in transit on second day.	246, 251, 252, 255	"Advance schedule" shipments.
Do	do	do	Transcontinental.	do	1. Initial ice, 1 re-icing in transit; or 2. Standard Refrigeration, half-stage.	201, 246, 251, 252, 255	

See footnotes at end of table.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do.....	do.....	do.....	East, Midwest, 4 to 5 days.	Precool with car fans.	1. Pre-ice, re-ice 24 to 30 hr. after loading; or 2. Pre-ice, replenish by ship- per, do not re-ice, Com- bination Ventilation; close vents at 25°, open vents above 25° from Waycross or Savannah to a desig- nated point, Standard Ventilation thereafter.	240, 246, 251, 252, 385	1. Early fall; warm weather. 2. Late fall; cool weather.
Do.....	do.....	do.....	Transconti- nental.	do.....	Pre-ice, replenish by shipper, 1 re-icing in transit.	246, 251, 252	
Do.....	do.....	December 15 to April.	East, Midwest, 2 to 3 days.	Not precooled...	Combination Ventilation; close vents at 25°, open vents above 25° to a desig- nated point, Standard Ven- tilation thereafter.	385	
Do.....	do.....	do.....	3 to 4 days	do.....	1. Initial ice, do not re-ice; or 2. Initial ice, 1 re-icing in transit on second day.	240, 251, 252	
Do.....	do.....	do.....	do.....	do.....	1. Initial ice, do not re-ice, Standard Ventilation be- yond Potomac Yard; or 2. Initial ice, 1 re-icing in transit on second day.	240, 251, 252, 385	1. "Advance sched- ule" shipments. 2. Warm weather; advance sched- ule shipments.
Do.....	do.....	do.....	5 to 7 days	do.....	1. Initial ice, 1 re-icing in transit on first or second day, Standard Ventila- tion beginning third or fourth night; or 2. Initial ice, do not re-ice, Standard Ventilation be- yond Potomac Yard.	240, 251, 252, 385	
Do.....	do.....	do.....	do.....	do.....	Initial ice, do not re-ice, Stand- ard Ventilation beyond Po- tomac Yard.	240, 385	"Advance sched- ule" shipments.
Do.....	do.....	do.....	Transconti- nental.	do.....	1. Initial ice, do not re-ice, Standard Ventilation be- ginning second night; or 2. Initial ice, 1 re-icing in transit on second day, Standard Ventilation be- ginning fourth or fifth night; or 3. Standard Refrigeration, half-stage.	201, 240, 251, 252, 255, 385	

Do	do	do	East, Midwest, 4 to 5 days.	Room precool or precool in car with mo- bile unit.	1. Initial ice, do not re-ice; or 2. Initial ice, half-stage, 1 re- icing in transit on second day.	240, 246, 251, 252, 255	1. "Advance sched- ule" ship- ments.  2. Warm weather; advance sched- ule shipments.
Do	do	do	do	do	1. Initial ice, do not re-ice, Standard Ventilation be- ginning third night after loading or at Potomac Yard; or 2. Initial ice, half-stage, 1 re- icing in transit on second day.	240, 246, 251, 252, 255, 385	
Do	do	do	do	Precool with car fans.	Pre-ice, replenish by shipper, do not re-ice, Combination Ventilation; close vents at 25°, open vents above 25° from Waycross or Savan- nah to a designated point, Standard Ventilation there- after.	240, 246, 385	
Do	do	do	do	do	1. Pre-ice, replenish by ship- per, do not re-ice, Stand- ard Ventilation beyond Potomac Yard. 2. Pre-ice, replenish by ship- per, 1 re-icing in transit on second day.	240, 246, 251, 252, 385	1. "Advance sched- ule" ship- ments.  2. Warm weather; advance sched- ule shipments.
Do	do	do	Transconti- nental.	do	Pre-ice, replenish by shipper, 1 re-icing in transit on third or fourth day.	246, 251, 252	
Do	do	do	do	Room precool, or precool in car with mo- bile unit.	Initial ice, 1 re-icing in transit on fourth day.	246, 251, 252	
Do	do	May and June	East, Midwest, 2 to 3 days.	Not precooled	Initial ice, do not re-ice	240	
Do	do	do	3 to 4 days	do	1. Initial ice, 1 re-icing in transit on second day; or 2. Standard Refrigeration, half-stage.	201, 251, 252, 255	
Do	do	do	East, Midwest, 5 to 7 days; transconti- nental.	do	Standard Refrigeration, half- stage.	201, 255	
Do	do	do	East, Midwest, 4 to 5 days.	Room precool or precool in car with mobile unit.	1. Initial ice, 1 re-icing in transit on second day; or 2. Standard Refrigeration, half-stage.	201, 246, 251, 252, 255	

See footnotes at end of table.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do.....	do.....	do.....	do.....	Precool with car fans.	Pre-ice, replenish by shipper, 1 re-icing in transit on second or third day.	246, 251, 252	
Do.....	do.....	May and June.	Transcontinental.	Room precool or precool in car with mobile unit.	Standard Refrigeration, half-stage.	201, 246, 255	
Do.....	do.....	do.....	do.....	Precool with car fans.	Pre-ice, replenish by shipper, Standard Refrigeration.	201, 246	
Do.....	Texas (Lower Rio Grande Valley).	October to June.	Same as for Texas grapefruit.	Not precooled.	Same protective services as for Texas nonprecooled grapefruit, during similar period and for same destinations. <sup>2</sup>	201, 240, 247, 385	
Tangerines.....	Florida (all points).	October to April.	3 to 5 days.	Room precool or precool in car with mobile unit.	Initial ice, do not re-ice.	240, 246	
Do.....	do.....	do.....	7 to 10 days.	do.....	Initial ice, 1 re-icing in transit.	246, 251, 252	
Cranberries (early season).	Massachusetts (Cape Cod).	September and October.	All points.	Not precooled.	When commodity loading temperature is under 50° F: Standard Ventilation. Standard Refrigeration from some designated point, if outside temperatures near destination are high.	201, 385	
Do.....	do.....	do.....	do.....	do.....	When commodity loading temperature is 50° to 55° F: Standard Refrigeration.	201	
Do.....	do.....	do.....	do.....	do.....	When commodity loading temperature is 55° to 60° F: Standard Refrigeration, 3% salt at initial and first two re-icings.	201, 202	
Do.....	do.....	do.....	do.....	Precool in car.	When commodity loading temperature is over 60° F: Pre-ice, replenish, Standard Refrigeration, 3% salt at pre-icing, replenishing, and first two re-icings.	201, 202, 246	

Cranberries (late season).	do.	November and December.	do.	Not precooled	When commodity loading temperature is under 50° F.: Standard Ventilation followed by Standard Refrigeration from some designated point, if outside temperatures near destination are high.	201, 385
Do	do	November and December.	All points	Not precooled	When commodity loading temperature is over 50° F.: Standard Refrigeration.	201
Dates	California (desert)	Summer	East, Midwest	Room precool	1. Initial ice, do not re-ice; or 2. Initial ice, 1 or 2 re-icings in transit.	240, 247
Do	do	Fall, winter, and spring.	do	Room precool or not precooled.	Standard Ventilation	385
Figs (fresh)	California (San Joaquin Valley).	June to September.	East, Midwest, 3 to 5 days.	Room or car precool, 33° to 36° F.	Pre-ice, Standard Refrigeration, 3% salt at pre-icing and all re-icings. 750 to 1,000 lb. of wrapped dry ice in brace, 100 lb. broken up in each bunker.	1, 4, 5, 15 Express movement
Grapes (Vimifera)	California (desert valleys).	June and July	All points	Room or car precool to 40° F. or lower.	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings.	1, 4, 5, 15; 201, 202, 246 Many of these shipments move via express. Fumigate with sulfur dioxide gas.
Do	California (San Joaquin and Sacramento Valleys).	August and September.	do	Precool in car, 40° to 50° F.	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings.	201, 202, 246 Fumigate with sulfur dioxide gas.
Do	do	do	do	Room or car precool, 38° to 45° F.	Pre-ice, Standard Refrigeration.	201, 246
Do	do	do	do	Room or car precool, 32° to 37° F.	Pre-ice, Standard Refrigeration, half-stage.	201, 246, 255 Do.
Do	do	September to November.	do	Precool in car, 40° to 50° F.	Pre-ice, replenish, 2 re-icings in transit.	246, 254 Do.
Do	do	do	do	Room precool, 36° to 45° F.	Pre-ice, Standard Refrigeration, half-stage.	201, 255 Do.
Do	do	do	do	Room precool, 31° to 35° F.	Pre-ice, replenish, 1 re-icing in transit.	254 Do.

See footnotes at end of table.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	do	November to March.	do	Cold storage	do	254	Do.
Peaches and nectarines.	California (central).	May to September.	East, Midwest, 5 to 9 days.	Room or car precool, or hydrocool 35° to 45° F.	Pre-ice, Standard Refrigeration, for fan cars. Same service for nonfan cars, except add 2% salt at pre-icing and all re-icings.	201, 202, 246	
Do	do	May to September.	East, Midwest; 5 to 9 days.	Room or car precool, or hydrocool to 35° F. or lower.	Pre-ice, replenish, 2 re-icings in transit.	246, 254	
Peaches	Colorado (Palm-sades, Grand Junction).	August	Midwest, West Coast; 3 to 5 days.	Precool in car	Pre-ice, Standard Refrigeration, 2 or 3% salt at first re-icing only, on basis of bunker capacity.	201, 202, 246	
Do	Georgia and South Carolina (southeast).	June to August	All points	Not precooled or precool in car.	Pre-ice, Standard Refrigeration, 2 or 3% salt at first re-icing only, on basis of bunker capacity.	201, 202, 246	
Do	do	do	do	Hydrocool	1. Pre-ice, Standard Refrigeration; or 2. Pre-ice, Standard Refrigeration, half-stage.	201, 255	
Do	Washington (Wenatchee, Yakima).	July and August	East, Midwest;	Room precool overnight.	Pre-ice, Standard Refrigeration, 3% salt at pre-icing and all re-icings.	201, 202	
Do	do	do	West Coast	do	Pre-ice, do not re-ice, 3% salt	202, 240	
Pears: Bartlett	California (Sacramento River, Marysville).	July	East; 7 to 10 days.	Not precooled	When commodity loading temperature is 75° F. or under: Initial ice, half-stage after loading, 3 re-icings in transit on fourth, sixth and seventh days.	247, 255	For immediate consumption.
Do	do	do	do	do	When commodity temperature is over 75° F: 1. Pre-ice, half-stage, replenish, 3 re-icings in transit on fourth, sixth, and seventh days; or	247, 254, 255	1. For immediate consumption.

Do-----	California (central, north- ern).	July to September.	do-----	Room or car precool 40° to 45° F.	Pre-ice, replenish, 1 re-icing in transit.	246, 254	2. Initial ice, half-stage, after loading, 3 re- icings in transit on third, fifth, and sixth days.	2. For immediate consumption. Moderate weather.
Do-----	do-----	August to October.	do-----	Cold storage-----	Pre-ice, replenish, do not re- ice.	254	Do.	For East Coast shipments, if the pears are moving into cold storage at destination, add 1 more re- icing in transit to the protective service shown.
Do-----	Oregon and Washington (Medford, Hood River, Wenatchee, Yakima).	September to November.	South; 6 to 10 days.	do-----	Pre-ice, replenish, 1 or 2 re- icings in transit.	247		
Do-----	do-----	do-----	East; 7 to 10 days.	do-----	Pre-ice, replenish, do not re- ice.	254		
Do-----	do-----	do-----	West Coast; up to 4 days.	do-----	1. Initial ice, do not re-ice; or 2. Initial ice, half-stage, 1 re- icing in transit.	240, 247, 255		
Bosc and Comice.	California (central and northern).	September	East; 7 to 10 days.	Room or car precool 35° to 45° F.	Pre-ice, replenish, 1 re-icing in transit.	246, 254		For fruit moving at harvest time.
Do-----	do-----	October to April.	do-----	Cold storage-----	Pre-ice, do not re-ice-----	240		
Do-----	Oregon and Washington (Medford, Yakima).	September to February.	South; 6 to 10 days.	Cold storage or room pre- cool.	1. Pre-ice, 1 or 2 re-icings in transit; or 2. Special Ventilation, keep vents closed, Carriers' Protective Service, then initial ice beyond Heater Territory for short hauls, do not re-ice. For more distant points, such as Florida, re-ice in transit.	240, 247, 515		1. Warm weather. 2. Cold weather.
Do-----	do-----	do-----	East; 7 to 10 days.	do-----	1. Pre-ice, 1 or 2 re-icings in transit; or 2. Special Ventilation, keep vents closed, Carriers' Protective Service.	247, 515		1. Warm weather. 2. Cold weather.

See footnotes at end of table.

TABLE 7.—*Fresh fruits shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do-----	do-----	Throughout entire season.	West Coast-----	do-----	Pre-ice, half-stage, 1 re-icing in transit.	247, 255	
Anjou-----	Oregon and Washington (Medford, Hood River, Wenatchee, Yakima).	September to April.	South; 6 to 10 days.	do-----	Same protective services as above for Oregon and Washington cold storage or room precooled Bosc and Comice pears destined to the South.	240, 247, 515	
Do-----	do-----	do-----	East; 7 to 10 days.	do-----	Same protective services as above for Oregon and Washington cold storage or room precooled Bosc and Comice pears destined to the East.	247, 515	
Do-----	do-----	Throughout entire season.	West Coast-----	do-----	Pre-ice, half-stage, 1 re-icing in transit.	247, 255	
Pineapples-----	Cuba (import via W. Palm Beach, Fla.)	Year-round-----	East; Midwest-----	Not precooled-----	Origin to West Palm Beach: Customary practice is to load in box cars, thence by car ferry to West Palm Beach for reloading in refrigerator cars. <sup>2</sup>		
Do-----	do-----	Winter-----	do-----	do-----	West Palm Beach to destination: 1. Standard Ventilation; <sup>2</sup> or 2. Shippers' Specified Service. Set thermostat on liquid fuel heaters at 42½° for ripe and 52½° for mature-green, keep vents closed. <sup>3</sup>	385, 519, 520	
Do-----	do-----	Spring and fall.	do-----	do-----	1. Standard Ventilation; <sup>2</sup> or 2. Initial ice, do not re-ice; <sup>2</sup> or 3. Initial ice, 1 re-icing in transit. <sup>2</sup>	240 251 385	1. Cool weather. 2. Moderate weather. 3. Warm weather.
Do-----	do-----	Summer-----	do-----	do-----	Standard Refrigeration <sup>2</sup> -----	201	
Plums (including fresh prunes).	California (central).	June to September.	East-----	Room or car precooled, 40° to 45° F.	Pre-ice, replenish, 2 re-icings in transit.	246, 254	For average maturity fruit in fan cars.

Do-----	do-----	do-----	do-----	do-----	Pre-ice, Standard Refrigeration.	201, 246	For average maturity fruit in nonfan cars
Do-----	do-----	do-----	do-----	Room or car precool, 35° to 40° F.	Pre-ice, replenish, 2 re-icings in transit.	246, 254	For fruit above average maturity in fan cars.
Do-----	do-----	do-----	do-----	do-----	Pre-ice, Standard Refrigeration, 2% salt at each re-icing.	201, 202, 246	For fruit above average maturity in nonfan cars.
Do-----	Idaho, Oregon and Washington (Emmett, Milton-Freewater, Yakima).	July to September.	do-----	Not precooled	Pre-ice, Standard Refrigeration, 2 or 3% salt at each re-icing. <sup>2</sup>	201, 202	
Do-----	do-----	do-----	East, Midwest--	Room precool or precool in car with mobile unit, 40° to 45° F.	Pre-ice, Standard Refrigeration. <sup>2</sup>	201, 246	
Do-----	do-----	do-----	West Coast--	do-----	Pre-ice, do not re-ice <sup>2</sup>	240, 246	
Strawberries--	California (Santa Clara and Pajaro Valleys).	April, May, September, and October.	East, Midwest--	Room precool, 33° to 38° F.	Pre-ice, Standard Refrigeration, 800 to 1,000 lb. wrapped dry ice in crate at brace, 100 lb. broken up in each bunker.	1, 15	Express movement.
Do-----	do-----	June to August--	do-----	do-----	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings, 800 to 1,000 lb. wrapped dry ice in crate at brace, 100 lb. broken up in each bunker.	1, 4, 15	Do.
Do-----	California (southern).	April to June--	do-----	do-----	do-----	1, 4, 15	Do.
Do-----	Florida (Plant City).	January to April.	All points; 3 to 4 days.	Room or car precool to 40° F.	Pre-ice, replenish, do not re-ice. <sup>2</sup>	1, 5, 15	Do.
Do-----	Louisiana (Hammond).	March to May--	East, Canada, Midwest; 3 to 5 days.	Precool in car with portable and car fans combined to 40° F.	Pre-ice, replenish before and after precooling. Add 200 lb. of salt to each bunker at first replenishing. Standard Refrigeration, 2 to 3% salt at each re-icing in transit during hot weather.	1, 4, 5, 15	Do.

<sup>1</sup> Rules 1 to 15 are from REA Express Perishable Protective Tariff No. 27; rules 201 and above are from Perishable Protective Tariff No. 18.

<sup>2</sup> Based on commercial practice.

TABLE 8.—*Fresh vegetables shipped by rail; Recommended protective services and applicable tariff rules*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Asparagus	California (Sacramento and San Joaquin Valleys).	March and April.	All points	Hydrocool to 40° F. or lower.	Pre-ice, Standard Refrigeration.	201	
Beans (snap)	Florida (Everglades, lower east coast, central).	October to May.	3 to 7 days	Hydrocool or car precool 45° to 50° F.	Initial ice, half-stage, do not re-ice. After second day in transit, Special Ventilation (close vents at 45°, open vents above 45°). In cold weather, Shippers' Specified Service, light one heater at 25°, 2nd heater at 15°, extinguish one heater at 20°, 2nd heater at 30° keep vents closed.	240, 241, 255, 385, 514 <sup>2</sup>	Late fall, winter; cool weather.
Do	do	do	do	do	Initial ice, do not re-ice	240	Early fall, late spring; warm weather.
Beets (bunched).	Texas (Rio Grande Valley, Crystal City, Uvalde, Coastal Bend).	November to March.	All points	Not precool	10,000 lb. top ice and 15 to 25 lb. package ice.	242	
Broccoli	California (All points).	Year-round	do	do	Standard Refrigeration and 10,000 to 15,000 lb. top ice, also package ice.	201, 242	
Do	Texas (Rio Grande Valley, Crystal City, Uvalde).	November to March.	do	do	10,000 lb. top ice and 35 lb. package ice.	242	
Cabbage	Arizona (Yuma, Phoenix).	Fall, winter, and spring.	do	do	9,000 to 18,000 lb. top ice	242	Wirebound crates.
Do	California (southern).	Winter	do	do	15,000 lb. top ice <sup>2</sup>	242	L.A. (Los Angeles) crates, channeled load. Mesh bags.
Do	do	do	do	do	Standard Refrigeration <sup>2</sup>	201	Fiberboard cartons
Do	do	Spring	do	do	Initial ice, do not re-ice, and 15,000 lb. top ice <sup>2</sup>	240, 242	L.A. crates, channeled load. Mesh bags.

Do	do	Summer	do	do	Bunker ice ranging from initial ice only to Standard Refrigeration, and 15,000 to 20,000 lb. top ice. <sup>2</sup>	201, 240, 242, 247, 254, 255	Protective Service dependent on weather. L.A. crates, channeled load. Mesh bags.
Do	do	Spring	do	do	Hydrocool or vacuum cool.	242	Moderate weather L.A. crates, channeled load. Mesh bags.
Do	do	do	do	do	Vacuum cool	201, 254, 255	1. Moderate weather. Fiberboard cartons. 2. Warm weather. Fiberboard cartons.
Do	California (southern).	Summer	All points	do	Hydrocool or vacuum cool.	242, 254	L.A. crates, channeled load. Mesh bags.
Do	do	do	do	do	Vacuum cool	201	Fiberboard cartons.
Cabbage (including Chinese variety).	Florida (north-east, central, Everglades).	Winter	do	do	Not precooled	240, 243	1. Southern shipments. 2. Canadian shipments.
Do	do	Spring	do	do	do	240, 243	
Do	do	Winter	do	do	Hydrocool	240, 243	1. Southern shipments. 2. Canadian shipments.
Do	do	Spring	All points	do	Hydrocool	240, 243	
Do	Florida (all points)	Late spring	do	do	do	201, 243	Hot weather.
Cabbage	Texas (Rio Grande Valley, Crystal City, Uvalde).	November to April.	do	do	Not precooled	242	Wirebound crates.
Do	do	do	do	do	do	242	Paper mesh bags.
Carrots (bunched).	Arizona (Yuma)	Winter	do	do	do	242	Wirebound crates.

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do-----	Arizona (Phoenix)	Spring	do-----	do-----	15,000 to 25,000 lb. top ice and package ice.	242	Do.
Do-----	California ( <i>a</i> , central coastal; <i>b</i> , Imperial Valley).	<i>a</i> , May to December; <i>b</i> , December to May.	do-----	do-----	1. 15,000 lb. top ice, and package ice; or 2. Up to 25,000 lb. top ice, and package ice; or 3. Bunker ice ranging from initial ice only to Standard Refrigeration, and up to 25,000 lb. top ice, also package ice.	201, 240, 242, 247, 254, 255	1. Cool weather. 2. Warm weather. 3. Hot weather.
Do-----	Texas (Rio Grande Valley, Crystal City, Coastal Bend, Uvalde).	December 15 to April 15.	do-----	do-----	9,000 to 18,000 lb. top ice, and 25 to 35 lb. package ice. <sup>2</sup>	242	
Carrots (topped and prepackaged).	Arizona (Yuma)	Winter	do-----	do-----	9,000 to 18,000 lb. top ice---	242	Crates.
Do-----	do-----	do-----	do-----	do-----	Pre-ice, 1 or 2 re-icings in transit.	247	Fiberboard cartons or multiwall bags.
Do-----	Arizona (Phoenix)	Spring	do-----	do-----	9,000 to 18,000 lb. top ice---	242	Crates.
Do-----	do-----	do-----	do-----	Hydrocool to 50° F. or lower.	1. Pre-ice, do not re-ice; or 2. Pre-ice, 1 re-icing in transit.	240, 247	Crates, fiberboard cartons, or bags (hydrocooled before prepackaging).
Do-----	California (Salinas).	May to December.	All points	Not precooled---	Initial ice, 1 re-icing in transit, and 18,000 lb. top ice for 6-wide load, 24,000 lb. for 5-wide load.	242, 247	Crates, 5-wide channeled load in nonfan ears, 6-wide solid load in fan cars.
Do-----	do-----	do-----	do-----	Hydrocool to 50° F. or lower.	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings.	201, 202	Fiberboard cartons, chimney or end-to-end channeled load (hydrocooled before prepackaging).
Do-----	do-----	do-----	do-----	Hydrocool to 40° F. or lower.	Pre-ice, Standard Refrigeration, half-stage.	201, 255	Fiberboard cartons, chimney or end-to-end channeled load. Wirebound crates or multiwall paper bags.

Do	Texas (Herford)	August to December.	do	Not precooled	9,000 to 18,000 lb. top ice	242	Crates, channeled load.
Do	Texas (Rio Grande Valley, Coastal Bend, Winter Garden).	December to April.	do	do	do	242	Do.
Do	Texas (Rio Grande Valley, Coastal Bend, Crystal City, Uvalde).	do	2 to 3 days	Hydrocool to 50° F. or lower.	Pre-ice by carrier, replenish by shipper, do not re-ice.	240	Fiberboard cartons, chimney load. Multiwall paper bags, chimney or lengthwise flat loading.
Do	do	do	North, 4 to 6 days.	do	Pre-ice, 1 re-icing in transit at third icing station.	247	Fiberboard cartons or wirebound crates, channeled load.
Do	do	do	Northwest, 7 to 10 days.	do	Pre-ice, 2 re-icings in transit at third and seventh icing stations.	247	Do.
Carrots (topped and jumble-packed).	do	December 15 to April 15.	All points	Not precooled	9,000 to 18,000 lb. top ice <sup>2</sup>	242	Crates, paper mesh bags, or multiwall paper bags.
Cauliflower	California (central, coastal).	December to May.	All points	Not precooled	Standard Refrigeration and 15,000 to 18,000 lb. top ice, retop ice in transit on long hauls. <sup>2</sup>	201, 242, 248	Cool weather. Channeled load.
Do	do	do	do	Hydrocool to 40° F. or lower.	Pre-ice, Standard Refrigeration, and 15,000 lb. top ice on long hauls. <sup>2</sup>	201, 242	Hot weather. Channeled load.
Do	New York (Long Island).	September to November 15.	East or Northeast; 2 to 3 days.	Not precooled	12,000 lb. top ice	243	Channeled load.
Do	do	do	Southeast, Midwest; 3 to 5 days.	do	12,000 lb. top ice, retop ice in transit, depending on weather. In addition, pre-ice, half-stage, during hot weather, do not re-ice.	240, 243, 248, 255	Do.
Do	do	do	South to Southwest, Midwest; 5 to 7 days.	do	12,000 lb. top ice, retop ice in transit, depending on weather. In addition, pre-ice, full bunker, during hot weather, do not re-ice.	240, 243, 248	Do.
Do	do	November 15 to December 15	East or Northeast; 2 to 3 days.	do	12,000 lb. top ice	243	Do.

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	do	do	Southeast, Midwest: 3 to 5 days. All points	do	do	243	Do.
Cauliflower (trimmed and film-wrapped).	California (central coastal).	December to May.		Hydrocool or vacuum cool to 40° F.	Pre-ice, Standard Refrigeration. <sup>2</sup>	201	One-layer fiber-board cartons (hydrocooled before pre-packaging).
Do	Texas (Rio Grande Valley, Crystal City, Uvalde).	November to February.	do	Not precooled	15,000 lb. top ice <sup>2</sup>	242	
Celery	Arizona (Phoenix); California (southern, coastal).	Winter	Midwest, South	Hydrocool	1. 15,000 to 18,000 lb. top ice, mostly along sidewalls and in channels between rows; <sup>2</sup> or 2. Initial ice, do not re-ice, and 15,000 to 18,000 lb. top ice, mostly along sidewalls and in channels between rows. <sup>2</sup>	240, 242	
Do	do	do	East, Canada	do	15,000 to 18,000 lb. top ice, mostly along sidewalls and in channels between rows. Special Heater Protective Service, Set thermostat at 35° F. on liquid fuel heaters, keep vents closed. In Shippers' Specified Service Territory for charcoal heaters, light one heater at 15° second heater at 5°, extinguish one heater at 10° second heater at 20° keep vents closed. Standard Heating in Canada, keep vents closed.	242, 514 580	
Do	California (southern).	April to June	All points	do	Pre-ice, Standard Refrigeration, and 15,000 to 20,000 lb. top ice, mostly along side walls and in channels between rows.	201, 242	
Do	California (central coastal).	Summer	All points	Hydrocool (or vacuum cool to 40° F. or lower).	Pre-ice, Standard Refrigeration and 15,000 to 20,000 lb. top ice, mostly along sidewalls and in channels between rows.	201, 242	

Do-----	California (Sacramento Delta, southern coastal).	Fall and winter.	do-----	do-----	1. Initial ice, 1 or 2 re-icings in transit, and 15,000 to 20,000 lb. top ice, mostly along sidewalls and in channels between rows. <sup>2</sup> or 2. Initial ice, do not re-ice, and 15,000 to 20,000 lb. top ice, mostly along sidewalls and in channels between rows. <sup>2</sup>	240, 242, 247
Do-----	Florida (central, Everglades).	November to February.	East, Midwest--	Hydrocool-----	10,000 lb. top ice <sup>2</sup>	243
Do-----	do-----	do-----	Northeast, Canada.	do-----	6,000 to 10,000 lb. top ice, Shippers' Specified Service, light one heater at 15°, second heater at 5°, extinguish one heater at 10°, second heater at 20°, keep vents closed. Standard Heating in Canada, keep vents closed. <sup>2</sup>	243, 514
Do-----	Florida (central, northern).	March to June.	All points	do-----	Initial ice, re-ice in transit depending on weather, and 10,000 lb. top ice. <sup>2</sup>	243, 251, 252
Celery hearts (prepackaged).	California (central coastal, southern coastal).	Fall and winter.	do-----	Hydrocool or vacuum cool.	Pre-ice, Standard Refrigeration. <sup>2</sup>	201
Corn (sweet)----	California (all points).	May to November.	do-----	do-----	Pre-ice, Standard Refrigeration, 2% salt at initial and all re-icings, and 10,000 to 12,000 lb. top ice. Retop icing in transit may be necessary in hot weather. <sup>2</sup>	201, 202, 242, 248
Do-----	Florida (central, southern).	Fall to late spring.	do-----	do-----	1. Pre-ice, Standard Refrigeration and 10,000 to 20,000 lb. top ice; or 2. Pre-ice, Standard Refrigeration, 2% salt at all re-icings, and 10,000 to 20,000 lb. top ice.	201, 202, 243
Do-----	Texas (southern)---	April to June.	Midwest, 4 days; East, 6 days.	do-----	Pre-ice, Standard Refrigeration, 2% salt at initial and all re-icings, and 10,000 to 20,000 lb. top ice.	242
Cucumbers-----	Florida (all)-----	Fall and spring--	3 to 5 days-----	Not precooled----	Initial ice, 1 re-icing in transit <sup>2</sup> ----	251, 252

See footnotes at end of table.

Fiberboard cartons.

Hot weather.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	do	Winter	do	do	Initial ice, do not re-ice, Shippers' Specified Service, light one heater at 20°, second heater at 10°, extinguish one heater at 15°, second heater at 25°, keep vents closed. <sup>2</sup>	240, 514	
Endive and escarole.	Florida (central, southern).	November to May.	All points	Hydrocool	Initial ice, do not re-ice, and 10,000 lb. top ice. <sup>2</sup>	240, 243	
Lettuce	All points in Arizona and California.	October 1 to April 30.	do	Not precooled	15,000 to 20,000 lb. top ice, and approximately 30 lb. package ice.	242	Crates.
Do	do	May 1 to September 30.	do	do	Initial ice after loading, do not re-ice, and 20,000 to 25,000 lb. top ice, also approximately 30 lb. package ice.	240, 242	Do.
Do	Arizona and California (Blythe, Phoenix).	October 15 to December 1; March 1 to April 15.	do	Vacuum cool 33° to 35° F.	1. Pre-ice, Standard Refrigeration; or 2. Pre-ice, Standard Refrigeration, half-stage.	201, 255	Dry-pack.
Do	California (Imperial Valley).	December to February.	do	Precool with car fans for 10 to 12 hrs. 40° to 45° F.	Pre-ice, 300 lb. salt before pre-cooling. Replenish by shipper after precooling, and add 2% salt based upon amount of ice supplied, 2 re-icings in transit with no further salting.	202, 246, 247	Do.
Do	do	do	do	Vacuum cool 33° to 35° F.	1. Pre-ice, replenish, 1 re-icing in transit; or 2. Pre-ice, Standard Refrigeration, half-stage.	201, 254, 255	Do.
Do	California (Salinas, Watsonville).	April and May; October and November.	do	do	Pre-ice, Standard Refrigeration, half-stage.	201, 255	Do.
Do	do	June to September.	do	do	Pre-ice, Standard Refrigeration, 2% salt at pre-icing and all re-icings.	201, 202	Do.
Do	Texas (Hereford)	September 15 to November.	do	Not precooled	9,000 to 25,000 lb. top ice, depending on weather and distance, and approximately 35 lb. package ice.	242	Crates.
Do	Texas (Rio Grande Valley, Uvalde).	December to May.	do	do	do	242	Do.

Do-----	do-----	do-----	do-----	Vacuum cool 33° to 35° F.	Pre-ice, Standard Refrigeration, half-stage. <sup>2</sup>	201, 255	Dry-pack.
Do-----	do-----	do-----	do-----	Precool with car fans for 10 to 12 hr., 40° to 45° F.	Pre-ice, Standard Refrigeration. Add 2% salt before precooling on basis of bunk- or capacity. <sup>2</sup>	201, 202, 246	Do.
Melons: Cantaloups---	Arizona (desert valley).	May to July-----	All points-----	Top ice and portable or car fans; 35° to 40° F.	1. Pre-ice, Standard Refrigeration, and top ice (see tabulation below); or 2. Pre-ice, Standard Refrigeration, half-stage, and top ice (see tabulation below).	201, 242, 246, 255	Crates.
Do-----	California (a, Imperial Valley; b, San Joaquin Valley).	a, May and June; b, June to August.	do-----	do-----	1. Pre-ice, Standard Refrigeration, and top ice (see tabulation below); or 2. Pre-ice, Standard Refrigeration, half-stage, and top ice (see tabulation below).	201, 242, 246, 255	Do.
Do-----	California (San Joaquin and Sacramento Valleys).	September and October.	do-----	do-----	Pre-ice, Standard Refrigeration, half-stage, and top ice (see tabulation below).	201, 242, 246, 255	Do.
Do-----	Texas (Rio Grande Valley).	April to September.	do-----	do-----	Pre-ice, Standard Refrigeration and top ice (see tabulation below). The following quantities of top ice are required to reduce melon temperatures to 40°-45° F. from different average loading temperatures (3-layer loads): 95° F.-----11,800 lb. 90° F.-----11,000 lb. 85° F.-----9,500 lb. 80° F.-----8,000 lb. 75° F.-----7,200 lb. 70° F.-----6,300 lb. 65° F.-----5,500 lb. For 4-layer loads add one-third more top ice.	201, 242, 246	Do.
Honeydew---	Arizona (desert valley).	June and July-----	do-----	Not precooled---	1. Dry car loading; Standard Refrigeration; or 2. Dry car loading; Standard Refrigeration, half-stage.	201, 255	Treat with ethylene gas for 18 to 24 hr. (See text).

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	California (San Joaquin Valley).	July to October	do	do	1. Dry car loading; Standard Refrigeration, half-stage; or 2. Dry car loading; initial ice, half-stage, re-ice in transit as necessary.	201, 247, 255	1. Treat with ethylene gas for 18 to 24 hr. (See text). 2. Cool weather. Treat with ethylene gas for 18 to 24 hr. (See text).
Do	Texas (Rio Grande Valley).	May and June	All points	Not precooled	Dry car loading; Standard Refrigeration, half-stage. <sup>2</sup>	201, 255	Treat with ethylene gas for 18 to 24 hr. (See text).
Onions (dry)	Arizona and California (all points).	Spring	do	do	Standard Ventilation <sup>2</sup>	385	
Do	do	Summer	do	do	Dry car loading; Standard Refrigeration, half-stage.	201, 255	
Do	Idaho, Oregon, and Washington (all points).	Idaho, August to March; Oregon, August to April; Washington, June to February.	do	do	1. Standard Ventilation; <sup>2</sup> or 2. Special Ventilation, keep vents closed. <sup>2</sup>	385	
Do	New York (all points).	Fall	do	do	Standard Ventilation <sup>2</sup>	385	
Do	do	Winter	do	do	1. Special Ventilation, keep vents closed; <sup>2</sup> or 2. Carriers' Protective Service; <sup>2</sup> or 3. Shippers' Specified Service, light one heater at 10°, second heater at zero; extinguish one heater at 5°, second heater at 15°, Standard Ventilation. <sup>2</sup>	385, 514, 515	
Do	Texas ( <i>a</i> , Rio Grande Valley, Coastal Bend; <i>b</i> , northern; <i>c</i> , Hereford).	<i>a</i> , March to May; <i>b</i> , June; <i>c</i> , July and August.	do	do	Standard Ventilation <sup>2</sup>	385	
Peas (green)	California (San Joaquin Valley).	April and May; September to November.	All points	Hydrocool or vacuum cool.	Pre-ice, Standard Refrigeration and 10,000 to 12,000 lb. top ice. <sup>2</sup>	201, 242	

Peppers (sweet).	California (all points).	September to November.	do	Not precooled	1. Standard Refrigeration, half-stage; <sup>2</sup> or 2. Initial ice, half-stage, 1 or 2 re-icings in transit.	201, 247, 255
Do	Florida (all points).	December to April.	3 to 7 days.	do	When commodity loading tem- perature is under 70° F: Initial ice, half-stage, do not re-ice. After second day in transit, Special Ven- tilation (close vents at 45°, open vents above 45°). In cold weather Shippers, Specified Service, light one heater at 25°, second heater at 15°, extinguish one heat- er at 20°, second heater at 30°, keep vents closed. <sup>2</sup>	240, 255, 385, 514
Do	do	do	do	do	When commodity loading tem- perature is over 70° F: Initial ice, do not re-ice. Same ventilation and heat- er service as shown next above. <sup>2</sup>	240, 385, 514
Do	do	May and June	do	do	When commodity loading tem- perature is 70° to 80° F: Initial ice, half-stage, 1 re-icing in transit. <sup>2</sup>	251, 252, 255
Do	do	do	do	do	When commodity loading tem- perature is 80° to 90° F: Initial ice, 1 re-icing in transit. <sup>2</sup>	251, 252
Do	do	do	do	do	When commodity loading tem- perature is over 90° F: Standard Refrigeration, half-stage. <sup>3</sup>	201, 255
Do	Texas (Rio Grande Valley).	October to December.	All points.	do	When commodity loading tem- perature is under 70° F: Initial ice, half-stage, do not re-ice. After second day in transit, Special Ven- tilation (close vents at 45°, open vents above 45°). In cold weather, Special Heater Protective Services. Set thermostat at 45° F. on liquid fuel heaters, keep vents closed. In Shippers, Specified Service Territory for charcoal heaters, light one heater at 25°, second heater at 15°, extinguish one heater at 20°, second heater at 30°, keep vents closed.	240, 255, 385, 514, 580

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	do	do	do	do	When commodity loading temperature is over 70° F: Initial ice, do not re-ice. Same ventilation and Heater service as shown next above.	240, 385, 514, 580	
Potatoes: Early crop	Alabama (southern).	May and June	All points	Not precooled	1. Standard Ventilation; or 2. Initial ice, do not re-ice.	240, 385	1. Cool weather. 2. Hot weather and dependent on distance. Burlap bags (50 and 100 lb.). Paper bags (10 lb.).
Do	Arizona (Maricopa, Pinal, and Yuma counties); California (Kern County, San Joaquin Valley).	April to July (June and July for San Joaquin Valley).	Midwest, East	do	When commodity loading temperature is under 80° F: <sup>3</sup> Dry car loading, initial ice, half-stage, 2 re-icings in transit on third and fifth days. <sup>4</sup>	247, 255	Burlap bags (100 lb.), pyramid or "bump" load.
Do	do	do	do	do	When commodity loading temperature is 80° to 90° F: <sup>3</sup> 1. Dry car loading, initial ice, 1 re-icing in transit on fourth day; or 2. Dry car loading, Standard Refrigeration, half-stage.	201, 247, 255	Do.
Do	do	do	do	do	When commodity loading temperature is over 90° F: <sup>3</sup> 1. Pre-ice, replenish, 1 re-icing in transit on fourth day; or 2. Pre-ice, Standard Refrigeration, half-stage.	201, 254, 255	Do.
Do	do	do	do	Moderately pre-cool with car fans to 60° F.	Pre-ice, replenish, 1 re-icing in transit on fifth day. <sup>4</sup>	246, 254	Do.
Do	do	do	do	Not precooled	When commodity loading temperature is under 85° F: <sup>3</sup> Dry car loading; Standard Refrigeration, half-stage.	201, 255	Fiberboard cartons; master paper bags (50 lb.).

Do	do	do	do	do	do	When commodity loading temperature is over 85° F. <sup>3</sup> Pre-ice, Standard Refrigeration, half-stage.	201, 255	Do.
Do	do	do	do	do	Moderately pre-cool with car fans to 60° F.	Pre-ice, replenish, 1 re-icing in transit on fifth day. <sup>4</sup>	246, 254	Do.
Do	do	do	do	do	Not precooled	When commodity loading temperature is under 85° F. <sup>3</sup> Dry car loading, initial ice, half-stage, 2 re-icings in transit on third and fifth days. <sup>4</sup>	247, 255	Bags (10 lb.).
Do	do	do	do	do	do	When commodity loading temperature is over 85° F. <sup>3</sup> Pre-ice, Standard Refrigeration, half-stage.	201, 255	Do.
Do	do	do	do	do	Moderately pre-cool with car fans, 55° to 60° F.	Pre-ice, replenish, 1 re-icing in transit on fifth day. <sup>4</sup>	246, 254	Do.
Do	Florida (southern).	January to April.	All points.	do	Not precooled	Standard Ventilation.	385	Paper, cotton, or burlap bags (50 lb.); mesh bags.
Do	Florida (northern).	April to June.	do	do	do	1. Standard Ventilation; or 2. Initial ice, do not re-ice.	240, 385	1. Cool weather. 2. Hot weather. Burlap bags (50 and 100 lb.); paper bags (10 lb.).
Do	Texas (Hereford).	July.	3 to 4 days.	do	No precooling, or precool in car with mobile unit or car fans, 60° to 70° F.	Dry car loading, initial ice, do not re-ice. If precooled, delay icing 12 to 18 hours.	240, 246	Burlap bags (50 lb.).
Do	do	do	5 to 7 days.	do	do	Same as above, except 1 re-icing in transit on fourth day.	246, 247	Do.
Late crop	California (Stockton).	August and September.	All points.	do	Not precooled	Standard Refrigeration, half-stage.	201, 255	

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do.....	California (a, Tule Lake; b, Kern, Tulare, Riverside, and San Bernardino Counties).	a, October and November; b, December to February.	do.....	Storage.....	1. Standard Ventilation; or 2. Carriers' Protective Service; or 3. Special Heater Protective Service. Set thermostat at 40° F. on liquid fuel heaters; keep vents closed. In Shippers' Specified Service Territory for charcoal heaters, light one heater at 20°, second heater at 10°, extinguish one heater at 15°, second heater at 25°, keep vents closed.	385, 514, 515, 580	
Do.....	Idaho, Oregon, and Washington (all points).	July 4 to August 7 <sup>5</sup> (both inclusive).	South, East, North.	Not precooled.....	Standard Refrigeration, half-stage. <sup>2</sup>	200, 201, 255	This protective service is compulsory under Rule 200.
Do.....	do.....	do.....	West <sup>6</sup> .....	do.....	Initial ice, do not re-ice <sup>2</sup> .....	240	Compulsory protective service under Rule 200 does not apply.
Do.....	do.....	August 8 to August 28 <sup>5</sup> (both inclusive).	South, East, North.	do.....	1. Standard Refrigeration, half-stage; <sup>2</sup> or 2. Initial ice, 1 or more re-icings in transit. <sup>2</sup>	200, 201, 247, 255	These protective services are compulsory under rule 200.
Do.....	do.....	do.....	West <sup>6</sup> .....	do.....	Initial ice, do not re-ice <sup>2</sup> .....	240	Compulsory protective service under rule 200 does not apply.
Do.....	do.....	August 29 to September 11 <sup>5</sup> (both inclusive).	South, East, North.	do.....	1. Standard Refrigeration, half-stage; <sup>2</sup> or 2. Initial ice, 1 or more re-icings in transit; <sup>2</sup> or 3. Initial ice, do not re-ice. <sup>2</sup>	200, 201, 240, 247, 255	These protective services are compulsory under rule 200.
Do.....	do.....	do.....	West <sup>6</sup> .....	do.....	Initial ice, do not re-ice <sup>2</sup> .....	240	Compulsory protective service under rule 200 does not apply.
Do.....	do.....	September 12 to October 9 <sup>5</sup> (both inclusive).	South, East, North.	Not precooled.....	1. Initial ice, 1 or more re-icings in transit; <sup>2</sup> or 2. Initial ice, do not re-ice <sup>2</sup> .....	200, 240, 247	These protective services are compulsory under rule 200.

Do. do. do.	do.	West 6	do.	Standard Ventilation, followed by initial icing on third or fourth day, do not re-ice, keep vents closed thereafter. <sup>2</sup>	240, 385	Compulsory protective service under rule 200 does not apply.
Do. do.	October 10 through February. <sup>5</sup>	All points	Storage	1. Standard Ventilation; <sup>2</sup> or 2. Special Ventilation, keep vents closed, Carriers' Protective Service; <sup>2</sup> or 3. Special Heater Protective Service. Set thermostat at 40° F. on liquid fuel heaters, keep vents closed. In Shippers' Specified Service Territory for charcoal heaters, light one heater at 20°, second heater at 10°, extinguish one heater at 15°, second heater at 25°, keep vents closed. <sup>2</sup>	385, 514, 515, 580	Carriers' Protective Service compulsory November 16 through February.
Do. do.	March 1 to July 3 <sup>5</sup> (both inclusive).	do	do	1. Special Ventilation, keep vents closed, Carriers' Protective Service; <sup>2</sup> or 2. Special Heater Protective Service. Set thermostat at 40° F. on liquid fuel heaters, keep vents closed. In Shippers' Specified Service Territory for charcoal heaters, light one heater at 20°, second heater at 10°, extinguish one heater at 15°, second heater at 25°, keep vents closed; <sup>2</sup> or 3. Standard Ventilation; <sup>2</sup> or 4. Initial ice, do not re-ice; <sup>2</sup> or 5. Initial ice, 1 re-icing in transit. <sup>2</sup>	240, 247, 385, 514, 515, 580	Protective service dependent on weather and distance.
Do. Maine (northern)	September and October.	do	Not precooled	Standard Ventilation	385	Master paper bags (50 lb.); paper bags (10, 15, and 50 lb.); burlap bags (100 lb.).
Do. do.	November to April 30.	do	Storage	1. Shippers' Protective Service. Set thermostat at 45° F. on liquid fuel heaters, keep vents closed; or 2. Standard Ventilation.	385, 510	Do.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do.....	do.....	May, June, and July.	South.....	do.....	1. Initial ice, 1 re-icing in transit on third or fourth day; <sup>2</sup> or 2. Free initial icing up to 5,000 lb. may be made available during this period by one railroad. <sup>2</sup>	201, 237	Re-icing in transit subject to Standard Refrigeration charges. Master paper bags (50 lb.); paper bags (10, 15, and 50 lb.); burlap bags (100 lb.).
Do.....	do.....	do.....	Pennsylvania or north and west thereof.	do.....	1. Initial ice, do not re-ice; <sup>2</sup> or 2. Free initial icing up to 5,000 lb. may be made available during this period by one railroad. <sup>2</sup>	237, 240	Master paper bags (50 lb.); paper bags (10, 15, and 50 lb.); burlap bags (100 lb.).
Do.....	Minnesota and North Dakota (Red River Valley).	August 15 to September 30.	Mainly midwest from Gulf of Mexico to Canada; 4 to 7 days.	Not precooled.....	When commodity loading temperature is under 70° F: Initial ice, half-stage, 1 re-icing in transit on fourth or fifth day.	247, 255	Burlap bags (50 and 100 lb.) in pyramid load on blanket pads; paper and mesh bags (50 lb.); paper, polyethylene, and mesh bags (10 lb.) in master paper bags.
Do.....	do.....	do.....	do.....	do.....	When commodity loading temperature is over 70° F: 1. Initial ice, half-stage, 1 re-icing in transit on fourth or fifth day; or 2. Pre-ice, half-stage, replenish, 1 re-icing in transit on fourth or fifth day; or 3. Pre-ice, Standard Refrigeration, half-stage.	201, 247, 255	Do.
Do.....	do.....	October 1 to April 30.	do.....	Storage.....	1. Standard Ventilation; or 2. Carriers' Protective Service; or 3. Special Heater Protective Service. Set thermostat at 40° F. on liquid fuel heaters, keep vents closed. In Shippers' Specified Service Territory for charcoal heaters, light one heater at 20°, second heater at 10°, extinguish one heater at 15°, second heater at 25°, keep vents closed.	385, 514, 515, 580	Do. Carriers' Protective Service compulsory November 16 through February.

Early crop, for chip- ping.	California (Kern and Tulare Counties).	April to July	All points	Not precooled	1. Standard Ventilation; or 2. Initial ice, do not re-ice, Standard Ventilation thereafter; or 3. Pre-ice, half-stage, 1 re- icing in transit on second or third day, Special Ventilation thereafter, keep vents open.	240, 247, 255, 385	Burlap bags (100 lb.).
Do	Florida (northern)	April to June	do	do	1. Standard Ventilation; or 2. 5,000 lb. ice, do not re-ice, Standard Ventilation thereafter.	237, 385	Do.
Late crop, for chip- ping.	Maine (northern)	November to April 30.	do	Storage	Shippers' Protective Service, 2 to 4 thermostatically con- trolled liquid fuel heaters with thermostats set at 60° F., keep vents closed.	510	Do.
Do	Minnesota and North Dakota (Red River Valley).	August 15 to April 30.	Mainly midwest from Gulf of Mexico to Canada; 4 to 7 days.	do	Standard Ventilation until about November 1, then Special Heater Protective Service, 2 to 4 thermo- statically controlled liquid fuel heaters with thermo- stats set at 60° F., keep vents closed. In Shippers' Specified Service Territory, for charcoal heaters, light one heater at 30°, second heater at 20°, extinguish one heater at 25°, second heater at 35°, keep vents closed.	385, 514, 580	Do.
Radishes (topped and prepack- aged).	Florida (central, southern).	October to January	East, Midwest	Hydrocool	10,000 lb. top ice <sup>2</sup>	243	Polyethylene bags in wirebound crates or baskets.
Do	do	February	do	do	Initial ice, do not re-ice, and 10,000 lb. top ice. <sup>2</sup>	240, 243	Do.
Do	do	March and April.	do	do	Initial ice, 1 re-icing in transit, and 10,000 lb. top ice. <sup>2</sup>	243, 251, 252	Do.
Do	do	May	do	do	Standard Refrigeration, half- stage, and 10,000 lb. top ice. <sup>2</sup>	201, 243	Do.
Spinach	Texas (Winter Garden).	November to April.	All points	Not precooled	Initial ice, do not re-ice, and 10,000 lb. top ice; also 20 lb. package ice.	240, 242	Crates or baskets.

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Sweetpotatoes.	Louisiana (southern).	Year-round.	East, Midwest.	Storage.	1. Special Ventilation (close vents at 55°, open vents above 55°). 2. Special Ventilation (close vents at 55°, open vents above 55°). Shippers Specified Service, light one heater at 25°, second heater at 15°, extinguish one heater at 20°, second heater at 30°.	385, 514	James crates (50 lb.); fiberboard cartons.
Tomatoes (mature-green).	California <i>a</i> , Imperial Valley; <i>b</i> , San Joaquin Valley; <i>c</i> , central and southern coastal).	<i>a</i> , May and June; <i>b</i> , June to August; <i>c</i> , July and August.	4 days	Not precooled.	When commodity loading temperature is 65° to 75° F. (for 4- and 5-layer loads): Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice, half-stage, do not re-ice, keep vents closed thereafter. <sup>7</sup>	240, 255, 385	Lug boxes.
Do	do	do	6 days	do	Same as above, except 1 re-icing in transit on third day with 1,500 lb. per bunker. <sup>7</sup>	247, 255, 385	Do.
Do	do	do	8 to 10 days	do	When commodity loading temperature is 65° to 75° F. (for 4- and 5-layer loads) Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice, half-stage, keep vents closed thereafter, 2 re-icings in transit on third and sixth days with 1,500 lb. per bunker. <sup>7</sup>	247, 255, 385	Do.
Do	do	do	4 days	do	When commodity loading temperature is 75° to 85° F. (for 4-layer loads): Dry car loading, Special Ventilation, keep vents open to first regular icing station, initial ice, half-stage, keep vents closed thereafter, do not re-ice. <sup>7</sup>	240, 255, 385	Do.

Do. . . . .	do. . . . .	6 days	do. . . . .	Same as above, except 1 re-icing in transit to half-stage capacity on third day. <sup>7</sup>	247, 255, 385	Do.
Do. . . . .	do. . . . .	8 to 10 days	do. . . . .	Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice, half-stage, keep vents closed thereafter, 2 re-icings in transit to half-stage capacity on third and sixth days. <sup>7</sup>	247, 255, 385	Do.
Do. . . . .	do. . . . .	4 days	do. . . . .	When commodity loading temperature is 85° to 90° F. (for 4-layer loads): 1. Pre-ice, half-stage, replenish at first regular icing station, do not re-ice; <sup>7</sup> or 2. Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice, full bunker capacity, keep vents closed thereafter, do not re-ice. <sup>7</sup>	240, 254, 255, 385	Do.
Do. . . . .	do. . . . .	6 days	do. . . . .	1. Pre-ice, half-stage, replenish at first regular icing station, 1 re-icing in transit to half-stage capacity on fourth day; <sup>7</sup> or 2. Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice full bunker capacity, keep vents closed thereafter, 1 re-icing in transit on fourth day with 2,000 lb. per bunker. <sup>7</sup>	247, 254, 255, 385	Do.

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do	do	do	8 to 10 days	do	1. Pre-ice, half-stage, replenish at first regular icing station, 2 re-icings in transit to half-stage capacity on third and sixth days <sup>7</sup> ; or 2. Dry car loading; Special Ventilation, keep vents open to first regular icing station, initial ice, full bunker capacity, keep vents closed thereafter, 2 re-icings in transit on third and sixth days with 2,000 lb. per bunker. <sup>7</sup>	247, 254, 255, 385	Do.
Do	do	do	4 days	do	When commodity loading temperature is over 90° F. (for 4-layer loads): Pre-ice, full bunker capacity, replenish at first regular icing station, do not re-ice. <sup>7</sup>	254	Do.
Do	do	do	6 days	do	Same as above, except 1 re-icing in transit on fourth day with 3,000 lb. per bunker. <sup>7</sup>	254	Do.
Do	do	do	8 to 10 days	do	Pre-ice, full bunker capacity, replenish at first regular icing station, 2 re-icings in transit on third and sixth days with 3,000 lb. per bunker. <sup>7</sup>	254	Do.
Do	do	do	4 and 6 days; 8 to 10 days	do	When commodity loading temperature is 75° to 80° F. (for 5-layer loads): Same protective services as shown for 75° to 85° F. commodity loading temperature in 4-layer loads. <sup>7</sup>	240, 247, 255, 385	Do.
Do	do	do	do	do	When commodity loading temperature is 80° to 85° F. (for 5-layer loads): Same protective services as shown for 85° to 90° F. commodity loading temperature in 4-layer loads. <sup>7</sup>	240, 247, 254, 255, 385	Do.

Do.-----	do.-----	do.-----	do.-----	do.-----	do.-----	254	Do.
When commodity loading temperature is over 85° F. (for 5-layer loads): Same protective services as shown for commodity loading temperature of over 90° F. in 4-layer loads. <sup>7</sup>							
Do.-----	California (San Joaquin Valley)	August to November.	All points	do.-----	do.-----	385, 514, 580	Do.
When commodity loading temperature is 50° to 55° F.:							
1. Special Ventilation, keep vents closed origin to destination; <sup>7</sup> or							
2. Special Ventilation, keep vents closed origin to Roseville, Special Heater Protective Service beyond Roseville.							
Set thermostat at 50° F. on liquid fuel heaters, keep vents closed.							
Also use this same liquid fuel heater service in Shippers' Specified Service Territory, keep vents closed. <sup>7</sup>							
Do.-----	do.-----	do.-----	do.-----	do.-----	do.-----	240, 255	Do.
When commodity loading temperature is 55° to 60° F.:							
Initial ice, half-stage, with 1,000 lb. per bunker, do not re-ice. <sup>7</sup>							
Do.-----	do.-----	do.-----	do.-----	do.-----	do.-----	240, 255	Do.
When commodity loading temperature is 60° to 65° F.:							
Initial ice, half-stage, with 2,000 lb. per bunker, do not re-ice. <sup>7</sup>							
Do.-----	do.-----	do.-----	do.-----	do.-----	do.-----	240, 255	Do.
When commodity loading temperature is 65° to 75° F.:							
Initial ice, half-stage, with 3,000 lb. per bunker, or to half-stage capacity, do not re-ice. <sup>7</sup>							
Do.-----	do.-----	do.-----	do.-----	do.-----	do.-----	240	Do.
When commodity loading temperature is 75° to 80° F.:							
Initial ice (grates in full bunker position) with 4,000 lb. per bunker, do not re-ice. <sup>7</sup>							

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective tariff rules and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do-----	do-----	do-----	do-----	do-----	When commodity loading temperature is 80° to 90° F: 1. Initial ice, full bunker capacity, do not re-ice; <sup>7</sup> or 2. Initial ice, full bunker capacity, 1 re-icing in transit with 1,000 to 2,000 lb. per bunker on fifth day. <sup>7</sup>	240, 247	
Do-----	Florida (central, southern).	November to May.	3 to 7 days.	do-----	When commodity loading temperature is 50° to 55° F: Special Ventilation, keep vents closed. Shippers' Specified Service. Set thermostat at 50° F on liquid fuel heaters, keep vents closed. <sup>7</sup>	385, 519, 520	Wirebound crates, lug boxes, fiber-board two-compartment cartons, fiber-board telescope cartons.
Do-----	do-----	do-----	do-----	do-----	When commodity loading temperature is 55° to 60° F: Initial ice, half-stage, with 1,000 lb. per bunker, do not re-ice. Shippers' Specified Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed. <sup>7</sup>	240, 255, 519, 520	Do.
Do-----	do-----	do-----	do-----	do-----	When commodity loading temperature is 60° to 65° F: Initial ice, half-stage, with 2,000 lb. per bunker, do not re-ice. Shippers' Specified Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed. <sup>7</sup>	240, 255, 519, 520	Do.
Do-----	do-----	do-----	do-----	do-----	When commodity loading temperature is 65° to 75° F: Initial ice, half-stage, with 3,000 lb. per bunker, or to half-stage capacity, do not re-ice. Shippers' Specified Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed. <sup>7</sup>	240, 255, 519, 520	Do.

Do-----do	do	do	do	do	When commodity loading temperature is 75° to 80° F.: Initial ice (grates in full bunker position) with 4,000 lb. per bunker, do not re-ice. Shippers' Specified Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed. <sup>7</sup>	240, 519, 520	Do.
Do-----do	do	do	do	do	When commodity loading temperature is over 80° F.: 1. Initial ice, full bunker capacity, do not re-ice. Shippers' Specified Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed; <sup>7</sup> or 2. Initial ice, full bunker capacity, 1 re-icing in transit. <sup>7</sup>	240, 251, 252, 519, 520	1. Wirebound crates, lug boxes, fiberboard two-compartment cartons, fiberboard telescope cartons. 2. Hot weather, same containers.
Do-----do	Mexico (import from west coast of Mexico, via Nogales, Arizona).	Fall and winter	2 to 3 days to border; all points beyond.	do-----do	Origin to Nogales: Standard Ventilation, close vents at 45° F.; <sup>7</sup> open vents above 45° F. <sup>7</sup>  Nogales to destination: 1. Same protective services as for California mature-green <i>fall</i> tomatoes, based on temperature of tomatoes on arrival at border, using Tucson as first icing station; <sup>7</sup> or 2. Special Ventilation, keep vents closed; <sup>7</sup> or 3. Special Heater Protective Service with thermostatically controlled liquid fuel heaters, using one heater from Tucson, a second heater in colder areas. Set heater thermostats at 50° F.; keep vents closed. Also use this same liquid fuel heater service in Shippers' Specified Service Territory, <sup>7</sup> keep vents closed. <sup>7</sup>	385	Lug boxes.
						240, 247, 255, 385, 514, 580	Do.

See footnotes at end of table.

TABLE 8.—*Fresh vegetables shipped by rail: Recommended protective services and applicable tariff rules—Continued*

Commodity and variety	Shipping point	Shipping season	Destination or transit period	Precooling method	Recommended or commonly used protective service	Rule <sup>1</sup>	Remarks
Do-----	do-----	Late spring-----	do-----	do-----	Origin to Nogales: Same icing schedule and ventilation service as for California mature-green <i>fall</i> tomatoes, based on tomato loading temperatures. Initial ice as soon as practicable after loading. <sup>7</sup> Nogales to destination: Same icing schedule and ventilation service as for California mature-green <i>fall</i> tomatoes, based on temperature of tomatoes on arrival at border, using Tucson as first icing station. <sup>7</sup>	240, 247, 255, 385	Do.
Do-----	Mexico (import from east coast of Mexico, via Laredo or Brownsville, Texas).	Fall, winter, and spring.	1 day to border; all points beyond.	do-----	Origin to Laredo or Brownsville: Transported by motor truck to border. Laredo or Brownsville to destination: 1. Same protective services as for California mature-green <i>fall</i> tomatoes, based on temperature of tomatoes on arrival at border; <sup>7</sup> or 2. Special Ventilation, keep vents closed; or 3. Special Heater Protective Service with thermostatically controlled liquid fuel heaters. Set heater thermostats at 50° F., keep vents closed. Also use this same liquid fuel heater Service in Shippers' Specified Service Territory, keep vents closed. <sup>7</sup>	240, 247, 255, 385, 514, 580	Do.
Do-----	Texas (lower Rio Grande Valley).	April 15 to June 15.	3 to 10 days-----	do-----	Initial ice (limit to 10,000 lb.), 1 or 2 re-icings in transit, keep vents closed (see table 9). <sup>7</sup>	247	
Do-----	Texas (east)-----	June 1 to July 1-----	3 to 9 days-----	do-----	Initial ice (limit to 10,000 lb.) 1 or 2 re-icings in transit, keep vents closed (see table 9). <sup>7</sup>	247	

Do-----	Texas (Laredo)-----	November and December.	All points-----	do-----	do-----	<p>1. Same protective services as for California mature green <i>fall</i> tomatoes;<sup>7</sup> or</p> <p>2. Special Ventilation, keep vents closed;<sup>7</sup> or</p> <p>3. For heater service when required, Special Heater Protective Service. Set thermostat at 50° F. on liquid fuel heaters, keep vents closed. Also use this same liquid fuel heater service in shippers' Specified Service Territory, keep vents closed.<sup>7</sup></p>	240, 247, 255, 385, 514, 580
Tomatoes (pink).	California (a, San Joaquin Valley, central; b, San Diego).	a, April to June; b, July to November.	All points within 6-day radius.	Room precool to 60° F.	<p>1. Pre-ice, half-stage, 2 re-icings in transit on second and fourth days;<sup>7</sup> or</p> <p>2. Pre-ice, half-stage, 1 re-icing in transit on third day.<sup>7</sup></p>	247, 255	For tomatoes breaking in color. Number of re-icings dependent on weather. Two layer lug boxes. <sup>8</sup>
Do-----	do-----	do-----	do-----	Room precool to 50° F.	<p>1. Pre-ice, half-stage, 2 re-icings in transit on second and fourth days;<sup>7</sup> or</p> <p>2. Pre-ice, half-stage, 1 re-icing in transit on third day;<sup>7</sup> or</p> <p>3. For heater service when required, Special Heater Protective Service. Set thermostat at 47½° F. on liquid fuel heaters, keep vents closed. Also use this same liquid fuel heater service in Shippers' Specified Service Territory, keep vents closed.<sup>7</sup></p>	247, 255, 514, 580	For tomatoes ripier than breaking in color. Number of re-icings dependent on weather. Two-layer lug boxes. <sup>8</sup>

<sup>1</sup> From Perishable Protective Tariff No. 18.

<sup>2</sup> Based on commercial practice.

<sup>3</sup> Applies to loads of 36,000 to 43,000 lb. during moderate weather. During warm weather deduct 5 degrees from commodity loading temperatures shown.

<sup>4</sup> Re-icing on fifth day not necessary for shipments scheduled for delivery on sixth day.

<sup>5</sup> These specific dates for shipping seasons are subject to change each year in Perishable Protective Tariff No. 18.

<sup>6</sup> Applies to shipments destined to points in California, Colorado, Idaho, Montana, Nevada, Oregon, Utah, Washington, and Wyoming; also to points in Arizona, Alberta, British Columbia, Manitoba, and Saskatchewan on shipments from Washington.

<sup>7</sup> Protection service based on use of fan cars, with fans in operation from origin to destination. Vents kept closed except where otherwise specified.

<sup>8</sup> Tomatoes of advanced color should be loaded in the ends of the car, and those breaking in color placed nearer the doorway.

TABLE 9.—*Texas mature-green tomatoes shipped by rail from lower Rio Grande Valley and east Texas: Recommended icing schedules for fan-equipped cars with fans in operation and vents kept closed*

Commodity loading temperature, size of load, and number of days in transit	Maximum initial icing <sup>1</sup>	First re-icing (third icing station) <sup>1 2</sup>	Second re-icing (seventh icing station)	Total ice supplied	Commodity loading temperature, size of load, and number of days in transit	Maximum initial icing <sup>1</sup>	First re-icing (second icing station) <sup>1 3</sup>	Second re-icing (sixth icing station)	Total ice supplied
75° to 80° F.	Pounds	Pounds	Pounds	Pounds	85° to 90° F.				
700 lugs:					700 lugs:				
3 to 4 days	10,000	1,800	0	11,800	3 to 5 days	10,000	3,600	0	13,600
5 to 7 days	10,000	2,700	0	12,700	6 to 7 days	10,000	3,600	1,800	15,400
8 days	10,000	2,700	1,800	14,500	8 days	10,000	3,600	2,700	16,300
9 days	10,000	2,700	2,700	15,400	9 days	10,000	3,600	3,600	17,200
10 days	10,000	2,700	3,600	16,300	10 days	10,000	3,600	4,500	18,100
840 lugs:					840 lugs:				
3 to 4 days	10,000	2,700	0	12,700	3 to 5 days	10,000	5,100	0	15,100
5 to 7 days	10,000	3,900	0	13,900	6 to 7 days	10,000	5,100	1,800	16,900
8 days	10,000	3,900	1,800	15,700	8 days	10,000	5,100	2,700	17,800
9 days	10,000	3,900	2,700	16,600	9 days	10,000	5,100	3,600	18,700
10 days	10,000	3,900	3,600	17,500	10 days	10,000	5,100	4,500	19,600
1,000 lugs or 532 wirebound crates:					1,000 lugs or 532 wirebound crates:				
3 to 4 days	10,000	3,600	0	13,600	3 to 5 days	10,000	6,600	0	16,600
5 to 7 days	10,000	5,100	0	15,100	6 to 7 days	10,000	6,600	2,100	18,700
8 days	10,000	5,100	2,100	17,200	8 days	10,000	6,600	3,000	19,600
9 days	10,000	5,100	3,000	18,100	9 days	10,000	6,600	3,900	20,500
10 days	10,000	5,100	3,900	19,000	10 days	10,000	6,600	4,800	21,400
616 wirebound crates:					616 wirebound crates:				
3 to 4 days	10,000	4,500	0	14,500	3 to 5 days	10,000	8,100	0	18,100
5 to 7 days	10,000	6,600	0	16,600	6 to 7 days	10,000	8,100	2,100	20,200
8 days	10,000	6,600	2,100	18,700	8 days	10,000	8,100	3,000	21,100
9 days	10,000	6,600	3,000	19,600	9 days	10,000	8,100	3,900	22,000
10 days	10,000	6,600	3,900	20,500	10 days	10,000	8,100	4,800	22,900
80° to 85° F.					90° F. and over				
700 lugs:					700 lugs:				
3 to 4 days	10,000	2,700	0	12,700	3 to 5 days	10,000	4,500	0	14,500
5 to 7 days	10,000	3,600	0	13,600	6 to 7 days	10,000	4,500	1,800	16,300
8 days	10,000	3,600	1,800	15,400	8 days	10,000	4,500	2,700	17,200
9 days	10,000	3,600	2,700	16,300	9 days	10,000	4,500	3,600	18,100
10 days	10,000	3,600	3,600	17,200	10 days	10,000	4,500	4,500	19,000
840 lugs:					840 lugs:				
3 to 4 days	10,000	3,900	0	13,900	3 to 5 days	10,000	6,600	0	16,600
5 to 7 days	10,000	5,100	0	15,100	6 to 7 days	10,000	6,600	1,800	18,400
8 days	10,000	5,100	1,800	16,900	8 days	10,000	6,600	2,700	19,300
9 days	10,000	5,100	2,700	17,800	9 days	10,000	6,600	3,600	20,200
10 days	10,000	5,100	3,600	18,700	10 days	10,000	6,600	4,500	21,100
1,000 lugs or 532 wirebound crates:					1,000 lugs or 532 wirebound crates:				
3 to 4 days	10,000	5,100	0	15,100	3 to 5 days	10,000	8,100	0	18,100
5 to 7 days	10,000	6,600	0	16,600	6 to 7 days	10,000	8,100	2,100	20,200
8 days	10,000	6,600	2,100	18,700	8 days	10,000	8,100	3,000	21,100
9 days	10,000	6,600	3,000	19,600	9 days	10,000	8,100	3,900	22,000
10 days	10,000	6,600	3,900	20,500	10 days	10,000	8,100	4,800	22,900
616 wirebound crates:					616 wirebound crates:				
3 to 4 days	10,000	6,600	0	16,600	3 to 5 days	10,000	10,000	0	20,000
5 to 7 days	10,000	8,100	0	18,100	6 to 7 days	10,000	10,000	2,100	22,100
8 days	10,000	8,100	2,100	20,200	8 days	10,000	10,000	3,000	23,000
9 days	10,000	8,100	3,000	21,100	9 days	10,000	10,000	3,900	23,900
10 days	10,000	8,100	3,900	22,000	10 days	10,000	10,000	4,800	24,800

<sup>1</sup> For tomatoes shipped from lower Rio Grande Valley, if car is initially iced before loading, increase the amount of ice added at first re-icing by 900 lb. For shipments from east Texas, if car is initially iced the day before load-

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ing it should be re-iced at *first* icing station instead of second or third with double the amount of ice shown in the schedule for *first re-icing*. In no case, however, should the amount of ice added at such re-icing, plus that still remaining in the bunkers from previous icing, exceed 10,000 lb.

<sup>2</sup> For east Texas shipments, if third icing station is reached less than 60 hours after initial icing, re-ice at fourth icing station instead.

<sup>3</sup> For east Texas shipments, if second icing station is reached less than 30 hours after initial icing, re-ice at third icing station instead.

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